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Psychospołeczne determinanty i konsekwencje zachowań siedzących w dwóch rodzajach diad

Psychosocial determinants and consequences of sedentary behavior in two types of dyads

Rozprawa doktorska przygotowana pod kierunkiem:

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Spis Treści

Abstrakt

Niniejsza rozprawa doktorska obejmuje cztery badania. Celem badań jest poznanie, jakie mogą być psychospołeczne predyktory (takie jak kontrola społeczna i satysfakcja z relacji) zachowań siedzących oraz ich potencjalne konsekwencje (takie jak objawy depresji) w dwóch rodzajach diad. Zależności między zmiennymi testowane były za pomocą diadycznych badań podłużnych, trwających 8 i 14 miesięcy. Do badań zostały wykorzystane dane pozyskane od dwóch rodzajów diad. Pierwszą grupę stanowiło 320 diad osób dorosłych, w których jedna osoba (osoba docelowa) zamierzała zwiększyć swój poziom aktywności fizycznej ze względu na chorobę przewlekłą lub zalecenia lekarskie, a druga zgodziła się jej towarzyszyć w procesie zmiany zachowań. Drugą grupę stanowiło 240 diad złożonych z rodziców i dzieci w wieku od 9 do 15 lat.

Celem diadycznych badań 1 i 2 była eksploracja zależności pomiędzy zmiennymi psychospołecznymi (takimi jak kontrola społeczna i satysfakcja z relacji), a zachowaniami siedzącymi w perspektywie podłużnej (trwającej 8 miesięcy), oraz porównanie wyników pomiędzy dwoma rodzajami diad (dorosły-dorosły oraz dorosły-dziecko). Celem badań 3 i 4 była ocena zależności wewnątrz-osobowych, między-osobowych oraz krzyżowych między zachowaniami siedzącymi, aktywnością fizyczną, a występowaniem symptomów depresji w diadach dorosły-dorosły oraz rodzic-dziecko (na przestrzeni 14 miesięcy). We wszystkich badaniach zachowania siedzące zostały zmierzone za pomocą trzyosiowych akcelerometrów, a zmienne psychospołeczne i objawy depresji za pomocą wystandaryzowanych narzędzi kwestionariuszowych. Do analiz zastosowano modele ścieżkowe przy użyciu schematu Actor Partner Interdependence Model with Mediators.

Wyniki analiz dostarczyły dowodów na występowanie kilku bezpośrednich oraz pośrednich efektów diadycznych. Badania 1 i 2 wykazały, że kontrola negatywna może być związana z niższym poziomem zachowań siedzących. Takich efektów nie uzyskano dla

kontroli pozytywnej. Efekt ten był stwierdzony w diadach, które odczuwają wysoką satysfakcję z relacji.

W przypadku Badań 3 i 4 uzyskano wyniki częściowo potwierdzające hipotezę błędnego koła pomiędzy zachowaniami siedzącymi a występowaniem objawów depresji. Zostały też odkryte efekty krzyżowe (tj. powiązania między dwoma różnymi zmiennymi mierzonymi u dwóch osób z diady). W obu przypadkach efekty uzyskane w grupie diad dorosłych nie były tożsame z tymi uzyskanymi w diadach rodzic-dziecko.

Podsumowując, zachowania siedzące i ich powiązania z procesami społecznymi oraz symptomami depresji w diadach rodzic-dziecko oraz dorosły-dorosły mają wiele wspólnych cech, ale ich dynamika różni się w zależności od typu relacji, która może wynikać z asymetrii ról w relacji rodzic-dziecko i bardziej partnerskiej dynamiki w diadach dorosły-dorosły.

Słowa kluczowe: zachowania siedzące, kontrola społeczna, satysfakcja z relacji, depresja, diady

Abstract

The aim of the research presented in this dissertation is to investigate potential psychosocial predictors of sedentary behaviors (such as social control and relationship satisfaction), and potential consequences of sedentary behaviors, namely depressive symptoms, within two types of dyads. The hypothesized relationships were tested using longitudinal dyadic studies spanning 8 and 14 months. Two types of dyads were enrolled in Studies 1-4. Adult-adult dyads (N = 320) included the focus person who intended to increase their physical activity due to chronic illness or medical recommendations, and the dyadic partner who agreed to support the focus person in the behavior change process. The second group consisted of 240 parent-child dyads with children aged 9 to 15 years old.

The aim of studies 1 and 2 was to explore the dyadic relationships between psychosocial variables (such as social control and relationship satisfaction) and sedentary behaviors from a longitudinal perspective (over 8 months) and to compare results between the two types of dyads. The aim of studies 3 and 4 was to examine intra-personal, inter-personal, and cross-over relationships between sedentary behaviors, physical activity, and depressive symptoms in adult dyads and parent-child dyads (over 14 months). In all studies, sedentary behaviors were measured using triaxial accelerometers, while psychosocial variables and depressive symptoms were assessed through standardized questionnaire tools. Path models were fit, using the Actor-Partner Interdependence Model with Mediators (APIM).

The results provided evidence of several direct and indirect dyadic effects. Studies 1 and 2 showed that negative control may have some beneficial effects in reducing sedentary behaviors, which was not observed for positive control. The significant effects of negative control were observed in dyads that reported high relationship satisfaction. In studies 3 and 4, results partially supported the hypothesis of a vicious cycle between sedentary behaviors and depressive symptoms. Cross-over effects (i.e., dyadic connections between different

variables) were also discovered. In both cases, the effects obtained in the adult-adult dyads differed from those observed in the parent-child dyads.

In summary, although sedentary behaviors and their associations with social processes and depressive symptoms share some common patterns across parent-child and adult-adult dyads, the dynamics of these relationships varies depending on the type of relationship, possibly due to role asymmetry in the parent-child relationship and more equal power dynamics in adult dyads.

Keywords: sedentary behavior, social control, relationship satisfaction, depression, dyads

Wprowadzenie

Wprowadzenie do tematyki zachowań siedzących (ZS)

Zachowania siedzące (ZS) definiuje się są jako każdą aktywność wykonywaną w stanie czuwania w pozycji siedzącej, leżącej lub półleżącej, charakteryzującą się niskim wydatkiem energetycznym (≤ 1,5 MET) (Tremblay i in., 2017). W ostatnich latach tego typu zachowania stały się coraz bardziej powszechne w różnych sferach aktywności człowieka, co wynika m.in., ze zmian w środowisku pracy, rozwoju technologii związanych z rozrywkami, oraz sposobów transportu i komunikacji (Owen i in., 2020). W ciągu ostatnich dekad czas poświęcany na zachowania siedzące znacząco wzrósł – badania z lat 2007–2016 wskazują na istotny wzrost średniego czasu zachowań siedzących z 5,7 do 6,4 godzin dziennie wśród dorosłych (Du i in., 2019).

Długotrwałe pozostawanie w pozycji siedzącej ma istotne, negatywne konsekwencje dla zdrowia somatycznego, między innymi w postaci zwiększonego ryzyka zaburzeń metabolicznych oraz cukrzycy typu 2. Dodatkowo ZS wiążą się ze wzrostem ciśnienia tętniczego oraz z zaburzeniami lipidowymi, co sprzyja rozwojowi chorób układu sercowo-naczyniowego (Patterson i in., 2018). Szacuje się, że ZS odpowiadają za około 0,5 miliona zgonów rocznie na całym świecie, co stanowi aż 3,8% wszystkich przyczyn śmiertelności (Rezende i in., 2014). W związku z tym, Światowa Organizacja Zdrowia (WHO, 2020) zaleca ograniczenie czasu spędzanego na zachowaniach siedzących i zastępowanie go aktywnością fizyczną (AF), co może pomóc w redukcji negatywnych skutków ZS dla zdrowia somatycznego.

Modele teoretyczne i mechanizmy wyjaśniające badane zależności

W przeprowadzonych badaniach analizowano zmienne takie jak pozytywna i negatywna kontrola społeczna oraz satysfakcja z relacji z drugą osobą. Dane pochodziły z dwóch rodzajów diad. Pierwsza grupa obejmowała diady dorosłych, w których jedna osoba

(osoba docelowa) planowała zwiększyć poziom swojej aktywności fizycznej ze względu na chorobę przewlekłą lub zalecenia lekarskie, a druga (partner) zgodziła się wspierać ją w procesie zmiany zachowań zdrowotnych. Druga grupa składała się z diad rodziców i dzieci w wieku od 9 do 15 lat.

Zmienne związane z procesem wymiany społecznej uznaje się za kluczowe potencjalne determinanty zachowań energetycznych, w tym zachowań siedzących (Rhodes i in., 2020). Kontrola społeczna jest jednym z przykładów takich zmiennych, które mogą wpływać na ZS, jak wskazały Lewis i Rook (1999). Kontrola społeczna to każda próba jednego z partnerów, mająca na celu wpłynięcie na zdrowie lub zachowania zdrowotne drugiego partnera (Craddock i in., 2015; Lewis i Rook, 1999). Pozytywna kontrola społeczna polega na stosowaniu perswazji, logiki i pozytywnego wzmocnienia, podczas gdy negatywna kontrola społeczna obejmuje wyrażanie negatywnych emocji lub próbę wywołania takich emocji u osoby docelowej, aby wpłynąć na jej zachowanie (np. poprzez krytykowanie czy wywoływanie poczucia winy [Lewis i Butterfield, 2007; Scholz i in., 2021]). W przeciwieństwie do wsparcia społecznego, interakcje związane z kontrolą społeczną nie muszą być afirmujące ani dostarczać zasobów (Lewis i Butterfield, 2007). Choć celem kontroli społecznej, zarówno pozytywnej, jak i negatywnej, jest wywołanie pozytywnych zmian w zachowaniach, sposób jej wyrażania może prowadzić do zwiększonego poziomu stresu (Lewis i Rook, 1999).

Według teorii wymiany społecznej (Thibaut i Kelley, 1959) satysfakcja z relacji jest rezultatem porównania korzyści i kosztów związanych z relacją. Wysoki poziom satysfakcji występuje, gdy korzyści (np. emocjonalne wsparcie, intymność, zrozumienie) przewyższają koszty (np. konflikty, ograniczenia, stres).

Diadyczny model wpływu zdrowotnego (Diadic Health Influence Model – DHIM; Huelsnitz i in., 2022) sugeruje złożone, pośrednie ścieżki, za pośrednictwem których

przekonania o relacji (takie jak satysfakcja z relacji) oraz strategie wpływu społecznego (np. kontrola społeczna) mogą wyjaśniać zachowania zdrowotne osoby docelowej, czyli takiej do której kierowana jest interwencja. Jak zaproponowano w DHIM (Huelsnitz i in., 2022), stosowanie przez partnera strategii wpływu (np. kontroli społecznej) może wyjaśniać przekonania relacyjne osoby docelowej (np. satysfakcję z relacji), które z kolei są związane z jej zachowaniami zdrowotnymi. Na przykład stosowanie przez partnera strategii kontroli społecznej może wywoływać myśli związane z relacją, takie jak zaangażowanie osoby docelowej w relację lub przekonania o jej znaczeniu. Postrzeganie wysokiej (lub polepszającej się) satysfakcji z relacji i jej znaczenia może skłaniać osobę docelową do zaangażowania się w zdrowsze zachowania (np. ograniczenie czasu ZS), co wynika z chęci uzyskania aprobaty partnera i utrzymania satysfakcjonującej relacji (Huelsnitz i in., 2022). Przegląd Huelsnitz i in. (2022) wskazuje jednak, że te hipotetyczne, pośrednie związki nie zostały jeszcze przetestowane. Ponadto DHIM (Huelsnitz i in., 2022) sugeruje, że przekonania relacyjne partnera (np. lęk związany z relacją, poczucie niezadowolenia) mogą skłonić go do stosowania strategii wpływu (w tym negatywnej kontroli społecznej, takiej jak wywoływanie poczucia winy), które z kolei mogą przewidywać zachowania zdrowotne osoby docelowej.

Zgodnie z DHIM (Huelsnitz i in., 2022) umiarkowany, lecz niewysoki poziom satysfakcji z relacji może skłonić partnerów do stosowania różnych strategii kontroli społecznej (pozytywnej lub negatywnej), aby wywołać zmianę w zachowaniu osoby docelowej. Z kolei osoba docelowa, którą cechuje duża satysfakcja z relacji, może być wrażliwa na nawet subtelne sygnały od partnera wskazujące na potrzebę zmiany (i tym samym ławiej dostrzegać stosowaną kontrolę społeczną). Postrzegana kontrola społeczna może skłonić osobę docelową do działania zgodnie z postrzeganą strategią wpływu (np.

negatywną kontrolą społeczną) i zaangażowania się w zdrowe zachowania, aby zadowolić partnera i utrzymywać satysfakcjonującą relację.

Zachowania siedzące a depresja

Oprócz powiązań między zachowaniami siedzącymi a zdrowiem somatycznym (Patterson i in., 2018), coraz więcej dowodów wskazuje na negatywne skutki długotrwałego siedzenia dla zdrowia psychicznego, takie jak, m in. wyższy poziom lęku (Stanczykiewicz i in., 2019) czy obniżona jakość życia (Boberska i in., 2018). Objawy depresji należą do najczęściej badanych wskaźników zdrowia psychicznego w kontekście zależności między ZS a zdrowiem psychicznym (Hallgren i in., 2020), co może wynikać z wysokiej częstości występowania depresji w populacji, która dotyka od 7% do 20 % ludzi w ciągu ich życia (Lim i in., 2019). Ograniczona skuteczność dostępnych terapii depresji podkreśla potrzebę lepszego zrozumienia behawioralnych czynników ryzyka związanych z jej wystąpieniem bądź nawrotem (Hallgren i in., 2020).

Zależności między ZS a późniejszymi objawami depresji są istotne, choć słabe, jak wskazują przeglądy systematyczne badań podłużnych (Huang i in., 2020). Również przeglądy łączące badania przekrojowe i podłużne wykazały niewielkie efekty (Saunders i in., 2020). Powiązania te mogą różnić się w zależności od rodzaju ZS, osiągając umiarkowane efekty w przypadku „biernych umysłowo" czynności siedzących, takich jak oglądanie telewizji, w porównaniu do „aktywnych umysłowo" ZS, takich jak czytanie (Hallgren i in., 2020). Większość dotychczasowych badań podłużnych opierała się na samoopisie ZS (np. 56 z 58 badań podłużnych uwzględnionych w przeglądzie Zhang i in., 2022), co jest istotne, ponieważ raportowany czas siedzenia znacznie różni się od wyników uzyskanych przy użyciu akcelerometru (samooceny wskazują średnio o 105 minut mniej dziennie, Prince i in., 2020). Stąd przeglądy systematyczne dotyczące ZS i objawów depresji mogą być obciążone stosunkowo niską rzetelnością oceny samoopisowej. Ostatnie badania z

wykorzystaniem akcelerometrów wskazują na istotne zależności przekrojowe między ZS a objawami depresji (Appelqvist-Schmidlechner i in., 2022; Hsiao i in., 2022), choć ze względu na ich przekrojowy charakter nie można ustalić kolejności występowania obu czynników.

Kilka hipotetycznych mechanizmów może wyjaśniać wewnątrzosobowe zależności między ZS a objawami depresji. ZS mogą zwiększać ryzyko nasilenia objawów depresji przez ograniczenie bezpośredniej komunikacji czy kontaktów z innymi osobami, zwiększając izolację społeczną i obniżając ogólny poziom interakcji społecznych (Huang i in., 2020). Wysoki poziom objawów depresji zwiększa także prawdopodobieństwo zastąpienia aktywności fizycznej dłuższym siedzeniem, co z kolei może zmniejszyć szanse na wyzdrowienie lub zwiększyć ryzyko nawrotu depresji (Huang i in., 2020). Inne modele sugerują, że ZS mogą wiązać się z wyższymi poziomami objawów depresji poprzez podniesienie poziomu markerów prozapalnych, co może stanowić biologiczny mechanizm pośredniczący (Hamer i Smith, 2018). Modele łączące objawy depresji i czas siedzenia sugerują, że mogą one wzajemnie się nasilać – ZS mogą zwiększać prawdopodobieństwo nasilenia objawów depresji, a wyższy poziom objawów depresji może zwiększać ryzyko dłuższego czasu siedzenia (Hallgren i in., 2020).

Istnieje kilka teoretycznych modeli wyjaśniających powiązania między zachowaniami zdrowotnymi a zdrowiem psychicznym u osób w bliskich relacjach, takich jak pary romantyczne, bliscy przyjaciele lub członkowie rodziny (Huelsnitz i in., 2022; Pietromonaco i in., 2013). Hipoteza wspólnych zasobów sugeruje, że pary romantyczne dzielą wspólne środowisko fizyczne i sieci społeczne, co sprawia, że są bardziej skłonne angażować się w podobne zachowania i przejawiać zbliżone nastroje (Meyler i in., 2007). Podobne zależności mogą występować również w innych rodzajach diad (np. bliskich przyjaciół, współpracowników, członków rodziny). Hipoteza zgodności zachowań zdrowotnych zakłada,

że kontrola społeczna może stanowić mechanizm konwergencji, w którym partnerzy próbują wpływać na siebie wzajemnie, oddziałując na swoje zachowania zdrowotne lub emocjonalne reakcje (Meyler i in., 2007). Hipoteza wspólnych zasobów oraz wpływu społecznego może tłumaczyć wyniki wskazujące na konwergencję i synchronizację czasu siedzenia mierzonego za pomocą akcelerometru u par romantycznych (Pauly i in., 2020). Hipoteza konwergencji nastroju zakłada podobieństwo lub „zarażanie afektywne" u par, a badania przekrojowe potwierdzają krzyżowe zależności w zakresie objawów depresji (Meyler i in., 2007). Chociaż mechanizmy konwergencji dwuosobowej zaproponowane przez Meyler i in. (2007) opracowano głównie w kontekście par romantycznych, wydaje się prawdopodobne, że mogą mieć zastosowanie także w innych rodzajach diad, które dzielą środowisko fizyczne i sieci społeczne.

Podsumowując, istnieje wiele modeli sugerujących wewnątrzosobowe, jak i krzyżowe zależności między ZS a objawami depresji, jednak sposób, w jaki te zależności zachodzą, nie jest jasny. Większość dotychczasowych badań zazwyczaj testowało zależności przekrojowe i/lub wewnątrzosobowe między czasem siedzenia a poziomem objawów depresji. Mnogość badań opartych na samoopisie kontrastuje z brakiem badań wykorzystujących akcelerometry do pomiaru czasu siedzenia. Większość dostępnych badań eksplorujących powiązania pomiędzy ZS a symptomami depresji dotyczy poprzecznych powiązań wewnątrzosobowych. Brakuje badań empirycznych sprawdzających międzyosobowe zależności między ZS a symptomami depresji w diadach rodzic-dziecko lub diadach złożonych z dwóch dorosłych, brakuje również dowodów na kierunek zależności między ZS a symptomami depresji w kontekście diadycznym. Niniejsze badania mają na celu wypełnienie tej luki.

Diady dorosły-dorosły a diady rodzic-dziecko: różnice i podobieństwa

W badaniach zostały przeanalizowane efekty diadyczne zbadane w dwóch różnego rodzaju diadach. Większość dotychczasowych badań nad rolą kontroli społecznej i jakości

relacji w rograniczaniu ZS oraz zależnościami pomiędzy symptomami depresji a ZS była prowadzona wśród osób dorosłych będących w relacji romantycznej. Relacje takie charakteryzują się stosunkowo równym układem sił. Uzyskane wzorce zależności mogą znacznie różnić się w diadach rodzic-dziecko w porównaniu do diad dwojga dorosłych. Relacje rodzic-dziecko są zazwyczaj asymetryczne ze względu na rolę rodzica jako opiekuna i autorytetu (Collins, 1995). Co więcej, rodzice często pełnią rolę „strażników" zdrowotnych zachowań swoich dzieci: kontrolując dostęp do różnych zasobów i możliwości, które mogą wpływać na aktywność i nawyki dzieci w sposób, który nie jest tak wyraźny w relacjach romantycznych dorosłych (Horodyska i in., 2019). Z drugiej strony nastolatkowie, przechodząc przez etap rozwojowy charakteryzujący się wzrastającą niezależnością (Koepke i Denissen, 2012), mogą postrzegać próby rodziców kontrolowania ich zachowań jako działania ograniczające ich swobodę wyboru (Brehm, 1966; Rosenberg i Siegel, 2018), co może skutkować niższą satysfakcją z relacji z rodzicem lub oporem wobec sugestii rodzica dotyczących ograniczenia ZS.

Cele badań własnych

Niniejsza rozprawa doktorska obejmuje cztery badania, których celem jest zrozumienie roli wybranych psychospołecznych predyktorów zachowań siedzących (kontrola pozytywna i negatywna, satysfakcja z relacji) oraz potencjalnych psychologicznych konsekwencji takich zachowań (symptomy depresji) w dwóch rodzajach diad. Eksplorowano również, czy zależności te będą identyczne w diadach dwóch osób dorosłych, oraz w diadach rodzic-dziecko. Zależności między zmiennymi analizowano za pomocą diadycznych badań podłużnych.

W odniesieniu do badania 1 i 2 sformułowano następujące pytania badawcze:

- Czy pozytywna i negatywna kontrola społeczna wyjaśnia redukcję zachowań siedzących u obu osób w diadzie?
- Czy satysfakcja z relacji (osoba docelowa-partner lub rodzic-dziecko) jest mediatorem zależności między kontrolą społeczną a zachowaniami siedzącymi czy też kontrola społeczna jest mediatorem relacji między satysfakcją z relacji a zachowaniami siedzącymi u obu osób w diadzie?

W odniesieniu do badań 3 i 4 sformułowano następujące pytania badawcze:

- Jakie są diadyczne (wewnątrz-osobowe i między-osobowe) zależności między zachowaniami siedzącymi, aktywnością fizyczną i występowaniem symptomów depresji w diadach osoba docelowa-partner oraz rodzic-dziecko ?
- Czy zachowania siedzące są predyktorami symptomów depresji, czy też symptomy depresji są predyktorami zachowań siedzących w diadach osoba docelowa-partner oraz rodzic-dziecko?

Badanie 1

(por. Siwa i in., 2023a)

Cel Badania 1

Celem pierwszego badania było zrozumienie, czy mechanizmy kontroli społecznej zarówno pozytywnej (np. wspieranie, przypomnienia) jak i negatywnej (np. krytyka, naciski) oraz poziom satysfakcji z relacji wyjaśniają zachowania siedzące (ZS) w diadach złożonych z dwóch dorosłych pozostających w bliskich relacjach (romantycznych, przyjacielskich). W badaniu skupiono się na diadach, w których jedna z osób chorowała przewlekle, natomiast druga z nich występowała w roli opiekuna, partnera w procesie zmiany zachowań zdrowotnych. Badanie miało na celu wyjaśnienie, czy satysfakcja z relacji pośredniczy w oddziaływaniu kontroli społecznej na ograniczanie zachowań siedzących, czy też zależność ta jest odwrotna – i to kontrola społeczna pełni rolę mediatora oddziaływania satysfakcji z relacji na ograniczanie zachowań siedzących.

Metoda Badania 1

Procedura badania

Badanie 1 przedstawia wyniki wtórnych analiz danych z randomizowanego badania z grupą kontrolną (zarejestrowanego w ClinicalTrials.gov, #NCT03011385). Badanie to analizowało efekty interwencji opartych na planowaniu aktywności fizycznej (7 sesji planowania/procedur kontrolnych przeprowadzonych w okresie między pierwszym i drugim pomiarem) połączonych z edukacją na temat zdrowego stylu życia (dotyczącą ZS, aktywności fizycznej i zdrowej diety). Główne zarejestrowane zmienne wynikowe to poziom umiarkowanej i intensywnej aktywności fizycznej i ZS, oceniany w okresie 8 miesięcy.

Wszyscy uczestnicy badania, zarówno osoby docelowe, jak i ich partnerzy uczestniczyli w identycznych sesjach edukacyjnych dotyczących ZS. Sesje te obejmowały definicje ZS, ich konsekwencje zdrowotne oraz strategie przerywania długich okresów ZS i

zmniejszania całkowitego czasu spędzanego na siedząco. W badaniu nie stosowano żadnych technik zmiany zachowania związanych z satysfakcją z relacji oraz kontrolą społeczną.

Badanie 1 miało charakter podłużny i trwało 8 miesięcy. Podczas pierwszego pomiaru (T1) zbierano dane za pomocą kwestionariuszy, dotyczące kontroli społecznej związanej z ZS oraz poziomu satysfakcji z relacji. Dodatkowo przez 6 dni mierzono ZS za pomocą akcelerometrów. Drugi pomiar (T2) wykonany 2 miesiące po T1 obejmował jedynie zmienne kwestionariuszowe. Pomiar trzeci (T3) przeprowadzony 8 miesięcy po T1 obejmował wyłącznie dane akcelerometryczne. Dane zbierano indywidualnie (diady wypełniały kwestionariusze oddzielnie) podczas spotkań z eksperymentatorem.

Dane zostały zebrane w okresie od grudnia 2016 do lutego 2020 w 24 lokalizacjach miejskich i 7 wiejskich w Polsce. Badanie zostało zatwierdzone przez Komisję Etyczną Badań Naukowych Uniwersytetu SWPS.

Osoby badane

Do badania zrekrutowano 640 dorosłych osób, tworzących $N = 320$ diad (320 osób docelowych i 320 partnerów). Pomiary po 8 miesiącach od T1 zostały ukończonne przez $n = 288$ osób docelowych i $n = 292$ partnerów, co oznacza, że odsetek osób, które zrezygnowały z badania, wyniósł jedynie 6,45 %.

Kryteria włączenia dla diad były następujące: (1) wiek ≥ 18 lat dla obu osób w diadzie; (2) diada obejmowała (a) wyróżnioną osobę docelową, czyli osobę, która nie spełniała zalecanych przez WHO (2010, 2020) kryteriów aktywności fizycznej i/lub otrzymała zalecenie od lekarza, aby zmniejszyć czas ZS i zwiększyć poziom aktywności fizycznej ze względu na chorobę przewlekłą, taką jak cukrzyca typu 2 lub choroby sercowo-naczyniowe, oraz (b) jej partnera; (3) osoba docelowa zgłaszała co najmniej umiarkowaną intencję do rozpoczęcia regularnej aktywności fizycznej; (4) diada była w bliskiej relacji, zdefiniowanej jako związek romantyczny lub inna bliska relacja (członkowie rodziny, bliscy

przyjaciele, współpracownicy) charakteryzująca się częstymi kontaktami, obejmującymi kilka spotkań w tygodniu; oraz (5) relacja trwała ≥ 6 miesięcy.

Początkowa próba osób docelowych (64,4 % kobiet) miała od 18 do 90 lat (*M* = 43,86, *SD* = 17,02), a partnerów (64,1 % kobiet) od 18 do 84 lat (*M* = 42,32 lat; *SD* = 16,55). Większość osób docelowych (61,6 %) i partnerów (51,0 %) miała nadwagę lub otyłość, 36,6 % osób docelowych i 47,1 % partnerów miało prawidłową masę ciała. Choroby przewlekłe zgłosilo 66,6 % osób docelowych oraz 40,6 % partnerów, w tym cukrzycę typu 2, choroby sercowo-naczyniowe lub inne choroby przewlekłe (np. zaburzeń układu mięśniowo-szkieletowego). Ponadto 87,8 % osób docelowych zadeklarowało niespełnianie zaleceń dotyczących aktywności fizycznej (WHO, 2010; 2020), a pozostałe 12,12 % otrzymało zalecenia lekarskie, aby poprawić poziom aktywności fizycznej z powodu stanu zdrowia. Wśród partnerów 77,5 % zgłosiło, że nie spełnia zaleceń dotyczących aktywności fizycznej. Większość diad była w związku romantycznym (61,6 %), natomiast 38,4 % diad pozostawało ze sobą w innych relacjach, (np. bliscy przyjaciele, członkowie rodziny, współpracownicy).

Narzędzia

Zachowania Siedzące (T1, T3). Czas ZS mierzono za pomocą trzyosiowych akcelerometrów ActiGraph GT3X-BT. Uczestnicy otrzymali szczegółowe instrukcje, dotyczące korzystania z urządzeń, i zostali poproszeni o codzienne raportowanie godzin noszenia akcelerometru podczas okresów czuwania przez 6 dni. Do analizy uwzględniano dane tylko od tych uczestników, którzy nosili urządzenie przez co najmniej 8 godzin dziennie przez minimum 3 dni w wymaganym okresie (Prescott i in., 2020). Czas ZS obliczano jako średnią minut spędzonych na siedzeniu w przeliczeniu na każdą godzinę noszenia urządzenia.

Postrzegana Pozytywna i Negatywna Kontrola Społeczna (T1 i T2). Kwestionariusz służący do oceny, czy osoby docelowe i ich partnerzy postrzegają, że druga osoba w diadzie stosowała pozytywną lub negatywną kontrolę społeczną w celu zachęcenia

do redukcji czasu ZS, składał się z 7 pytań. Pozytywną kontrolę społeczną oceniono za pomocą 4 pytań opartych na badaniach Lewis i Butterfield (2007) oraz Thorpe (2008): „W jaki sposób Twój partner wpływa (motywuje) Cię do ograniczenia czasu spędzanego na siedzeniu? (1) wielokrotnie przypomina Ci o aktywnych przerwach; (2) daje sugestie lub delikatne wskazówki; (3) używa humoru; (4) chwali i komplementuje." Negatywną kontrolę społeczną oceniono za pomocą 3 pytań opartych na badaniach Lewis i Butterfield (2007) oraz Thorpe (2008): „W jaki sposób Twój partner wpływa (motywuje) Cię do ograniczenia czasu spędzanego na siedzeniu? (5) jest uparty; (6) stara się wywołać u Ciebie poczucie winy; oraz (7) mówi, że zmieniłbyś się, gdybyś się o niego/nią troszczył." Odpowiedzi były udzielane na 4-punktowej skali od 1 (*nigdy tak nie robi*) do 4 (*bardzo często*).

Satysfakcja z Relacji (T1 i T2). Do pomiaru satysfakcji z relacji zastosowano czteroelementową wersję Indeksu Satysfakcji ze Związku (CSI-4; Funk i Rogge, 2007). Osoby badane zostały poproszone o ocenę swojego związku z drugą osobą w diadzie, odpowiadając na następujące pytania: „Proszę wskazać stopień szczęścia, uwzględniając wszystkie aspekty, w swoim związku," z odpowiedziami od 1 (*bardzo nieszczęśliwy*) do 4 (*bardzo szczęśliwy*); „Mam ciepły i komfortowy związek z moim partnerem," z odpowiedziami od 1 (*całkowicie się zgadzam*) do 4 (*całkowicie się nie zgadzam*); „Jak satysfakcjonujący jest Twój związek z partnerem?," z odpowiedziami od 1 (*wcale*) do 4 (*całkowicie*); „Ogólnie rzecz biorąc, jak bardzo jesteś zadowolony ze swojego związku?," z odpowiedziami od 1 (*wcale*) do 4 (*całkowicie*).

Zmienne kontrolne. Kowarianty socjodemograficzne wykorzystane w analizie wrażliwości obejmowały: (1) wiek; (2) płeć; (3) wykształcenie (podstawowe, zawodowe, średnie, policealne, licencjat, magisterskie); (4) samooceniany status ekonomiczny, z odpowiedziami w zakresie od 1 (*znacznie powyżej średniej rodziny w Polsce*) do 5 (*znacznie poniżej średniej rodziny w Polsce*); (5) typ relacji (związek romantyczny = 1, bądź inny = 0

(np. bliska przyjaźń, relacja zawodowa). Intencję do ograniczenia ZS w oceniano podczas pierwszego pomiaru (T1) za pomocą dwóch pytań (Maher i Conroy, 2015), m.in.: „Zamierzam siedzieć maksymalnie 5 godzin (łącznie) dziennie w ciągu najbliższego tygodnia.” Odpowiedzi mieściły się w zakresie od 1 (*zdecydowanie nie*) do 4 (*zdecydowanie tak*).

Analiza danych

W celu odpowiedzi na postawione pytania badawcze zastosowano analizy ścieżkowe, które przeprowadzono za pomocą oprogramowania IBM AMOS w wersji 26, wykorzystując metodę maksymalnego prawdopodobieństwa. W dwóch konkurencyjnych modelach założono, że osoby docelowe i ich partnerzy są rozróżnialni, i uwzględniono trzy punkty pomiarowe. Zmienne niezależne, mediacyjne i zależne oceniano w oddzielnych punktach czasowych, kontrolując jednocześnie poziom zmiennej zależnej w T1 (Byrne, 2010). Przeprowadzono analizę braków danych i analizy wrażliwości (poprzez dodanie potencjalnych zmiennych zakłócających).

Wyniki Badania 1

Wyniki dla modelu „Kontrola Społeczna → Satysfakcja z Relacji → Zachowania Siedzące”

Zakładany model, obliczony dla $N = 320$ diad, uzyskał następujące wskaźniki, świadczące o akceptowalnym dopasowaniu do danych: $\chi^2(14) = 25{,}39$, $p = 0{,}031$, $\chi^2/df = 1{,}814$, NFI = 0,975, CFI = 0,988, RMSEA = 0,051 (90 % CI [0,015, 0,081]). Zmienne w modelu wyjaśniały 41,9 % wariancji ZS (T3) osób docelowych oraz 51,5 % wariancji ZS (T3) u ich partnerów. Nie stwierdzono żadnych istotnych efektów pośrednich. Powiązania między zmiennymi niezależnymi (T1), mediatorami (T2) i zmiennymi zależnymi (T3), jak również główne wyniki przedstawiono na Rycinie 1.

Analiza wrażliwości, uwzględniająca płeć, wiek, wykształcenie i status ekonomiczny (T1) osób docelowych i partnerów, typ relacji (1 = romantyczna vs. 0 = inna) oraz analiza

modelu dwugrupowego, porównująca diady w relacjach romantycznych i nieromantycznych, wykazały wzorce efektów zgodne z wynikami uzyskanymi w modelu podstawowym.

Wyniki dla modelu „Satysfakcja z Relacji → Kontrola Społeczna → Zachowania Siedzące"

Zakładany model, obliczony dla $N = 320$ diad, uzyskał następujące wskaźniki, świadczące o akceptowalnym dopasowaniu do danych: $\chi^2(14) = 30{,}34$, $p = 0{,}007$, $\chi^2/df = 2{,}167$, NFI = 0,973, CFI = 0,985, RMSEA = 0,060 (90% CI [0,031, 0,090]). Zmienne w modelu wyjaśniały 40,5% wariancji czasu ZS (T3) osób docelowych oraz 50,5 % wariancji czasu ZS (T3) u ich partnerów. Analiza modelu wykazała dwa efekty pośrednie. Po pierwsze, wyższy poziom satysfakcji z relacji wśród osób docelowych (T1) był związany z postrzeganiem przez nie wyższego poziomu negatywnej kontroli (T2), co z kolei przewidywało krótszy czas ZS wśród osób docelowych (T3). Współczynnik efektu pośredniego był istotny, $b = -0{,}502$, $SE = 0{,}113$, 95 % CI [-1,027, -0,142], $p = 0{,}007$. Po drugie, niższy poziom satysfakcji z relacji partnerów (T1) wyjaśniał wyższy poziom postrzeganej negatywnej kontroli (T2) wśród osób docelowych, co z kolei wyjaśniało niższy poziom ZS (T3). Odpowiedni współczynnik efektu pośredniego był istotny, $b = -0{,}268$, $SE = 0{,}151$, 95 % CI [0,048, 0,668], $p = 0{,}011$. Powiązania między zmiennymi niezależnymi (T1), mediatorami (T2) i zmiennymi zależnymi (T3), jak również główne wyniki przedstawiono na Rycinie 2.

Analiza wrażliwości, uwzględniająca płeć, wiek, wykształcenie i status ekonomiczny (T1) osób docelowych i partnerów, typ relacji (1 = romantyczna vs. 0 = inna) oraz analiza modelu dwugrupowego, porównująca diady w relacjach romantycznych i nieromantycznych, wykazała wzorce efektów zgodne z wynikami modelu podstawowym.

Dyskusja wyników Badania 1

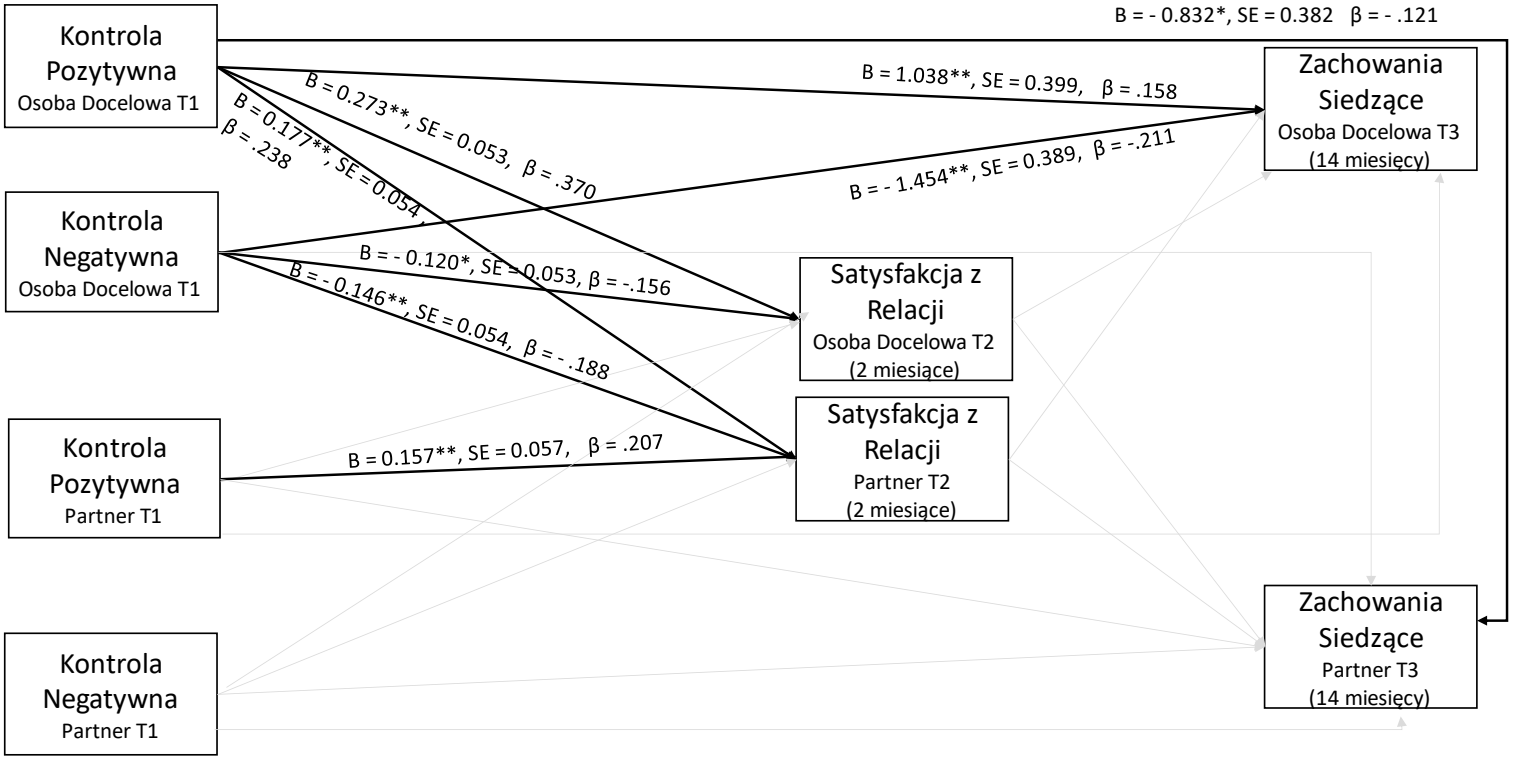
Wyniki Badania 1 częściowo potwierdzają jedną ze sformułowanych hipotez. Wyższa satysfakcja z relacji u osób docelowych oraz niższa satysfakcja u ich partnerów były

związane z wyższym poziomem raportowanego przez osoby docelowe zastosowania negatywnych technik kontroli społecznej przez partnera. Z kolei te techniki wyjaśniały krótszy czas ZS wśród osób docelowych. Hipoteza zakładająca ciąg zależności „kontrola społeczna → satysfakcja z relacji → czas ZS" nie została potwierdzona**.**

Poprzednie badania sugerowały, że negatywna kontrola społeczna może być predyktorem słabych, ale niekorzystnych zmian w zachowaniach prozdrowotnych (Craddock i in, 2015). Wyniki Badania 1 wskazują jednak, że efekty kontroli negatywnej należy rozpatrywać w kontekście satysfakcji z relacji w diadzie oraz poziomu postrzeganej negatywnej kontroli. W szczególności efekty pośrednie w Badaniu 1 należy interpretować w następującym kontekście: (1) nawet uczestnicy mniej zadowoleni z relacji zgłaszali umiarkowaną satysfakcję z relacji; (2) „wysoki poziom" postrzeganego użycia negatywnej kontroli oznaczał, że uczestnik zgłaszał sporadyczne stosowanie negatywnej kontroli przez drugą osobę w diadzie. Zgodnie z modelem DHIM (Huelsnitz, 2019) wydaje się, że umiarkowanie zadowolony partner w takiej diadzie może sporadycznie stosować pewną formę negatywnej kontroli społecznej, w celu wpłynięcia na zachowanie osoby docelowej. Z kolei osoba docelowa, która jest stosunkowo zadowolona z relacji, może postrzegać tę dawkę zastosowanej negatywnej kontroli jako akceptowalną i zastosować się do życzeń partnera, aby utrzymać jego zaangażowanie w relację.

Rycina 1.

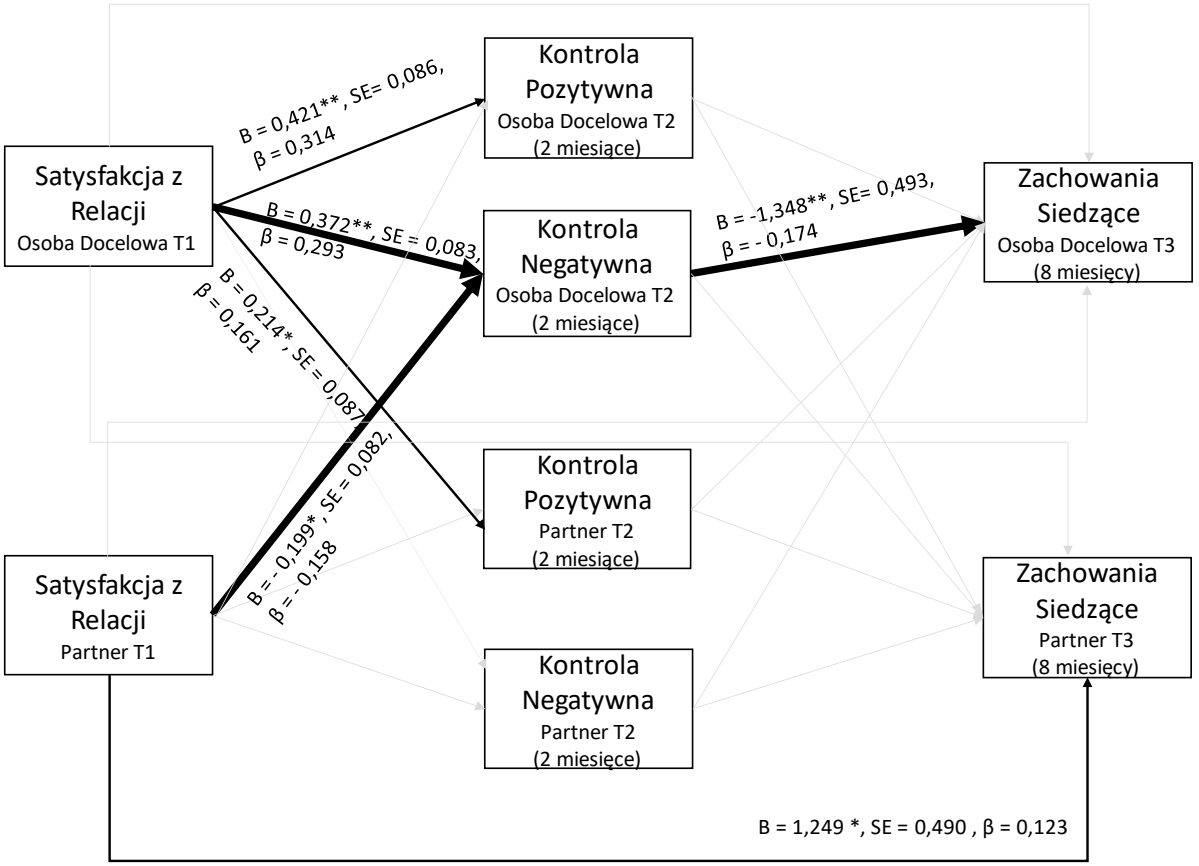
Bezpośrednie i pośrednie efekty dla modelu „Kontrola Społeczna → Satysfakcja z Relacji → Zachowania Siedzące”



Nota. ** $p < 0{,}01$; * $p < 0{,}05$. Istotne efekty zaznaczono liniami ciągłymi. Istotne efekty pośrednie oznaczono pogrubionymi liniami. Szare linie reprezentują efekty bezpośrednie, które nie były istotne. T1 = Pomiar 1, punkt wyjściowy; T2 = Pomiar 2, 8 tygodni po T1; T3 = Pomiar 3, 8 miesięcy po T1. Założono, że reszty wszystkich predyktorów, mediatorów i zmiennych wynikowych są skorelowane (dla przejrzystości nie przedstawiono kowariancji na Rycinie). Model kontrolował poziom zachowań siedzących w T1 (nie przedstawiono dla przejrzystości Ryciny).

Rycina 2.

Bezpośrednie i pośrednie efekty dla modelu „Satysfakcja z Relacji → Kontrola Społeczna → Zachowania Siedzące”



Nota. ** $p < 0{,}01$; * $p < 0{,}05$. Istotne efekty zaznaczono liniami ciągłymi. Istotne efekty pośrednie oznaczono pogrubionymi liniami. Szare linie reprezentują efekty bezpośrednie, które nie były istotne. T1 = Pomiar 1, punkt wyjściowy; T2 = Pomiar 2, 8 tygodni po T1; T3 = Pomiar 3, 8 miesięcy po T1. Założono, że reszty wszystkich predyktorów, mediatorów i zmiennych wynikowych są skorelowane (dla przejrzystości nie przedstawiono kowariancji na Rycinie). Model kontrolował poziom zachowań siedzących w T1 (nie przedstawiono dla przejrzystości Ryciny).

Badanie 2

(por. Siwa i in. 2024a)

Cele Badania 2

Celem drugiego badania było przetestowanie długoterminowych zależności między pozytywną i negatywną kontrolą społeczną stosowaną przez rodziców (oraz postrzeganą przez ich dzieci), satysfakcją z relacji oraz czasem spędzonym na zachowaniach siedzących (ZS) w diadach składających się z rodziców i ich dzieci w wieku od 9 do 15 lat. Zastosowane modele i metody badawcze były analogiczne do tych, które wykorzystano w badaniu diad dorosły-dorosły (Siwa i in., 2023a), co pozwoliło na zbadanie potencjalnych różnic i podobieństw w schematach zależności między dwoma typami diad.

Liczba badań wykorzystujących podłużne schematy badawcze do analizy zależności między predyktorami społecznymi a ZS jest ograniczona. Ponadto zgodnie z transteoretycznym modelem zmiany zachowania (Prochaska i DiClemente, 1983) wzorce zachowań powinny być obserwowane przez co najmniej 6 miesięcy, aby można było ustalić, czy dany wzorzec zachowania został utrwalony. Z tego względu w Badaniu 2 wybrano okres pomiędzy pomiarami ZS wynoszący > 6 miesięcy.

W oparciu o Model Diadycznego Wpływu Zdrowotnego (DHIM; Huelsnitz i in., 2022) oraz wytyczne do badania diadycznych zależności zdrowotnych (Pietromonaco i in., 2013), przetestowano dwa komplementarne modele mediacyjne. Pierwszy model zakładał, że stosowanie przez rodziców pozytywnej i negatywnej kontroli społecznej, jak również jej postrzeganie przez dzieci (Pomiar 1; T1) będą związane z ZS rodziców i dzieci (mierzone w Pomiarze 3, T3; 8 miesięcy po T1) w sposób pośredni, z satysfakcją z relacji rodziców i dzieci (Czas 2, T2; 2 miesiące po T1) jako mediatorem. Drugi model zakładał, że satysfakcja z relacji (T1) rodziców i dzieci będzie związana z ZS (T3) rodziców i dzieci pośrednio, z

pozytywną i negatywną kontrolą społeczną stosowaną przez rodziców i postrzeganą przez dzieci jako mediatorem.

Metoda Badania 2

Procedura badania

Badanie 2 przedstawia wyniki wtórnej analizy danych z randomizowanego badania z grupą kontrolną (zarejestrowanego w ClinicalTrials.gov, #NCT02713438). Celem badania była analiza efektów interwencji planowania aktywności fizycznej (7 sesji planowania/procedur kontrolnych przeprowadzonych w okresie między pierwszym a drugim pomiarem), połączonych z edukacją na temat zdrowego stylu życia, w tym ZS, aktywności fizycznej i zdrowej diety. Wszyscy rodzice i ich dzieci uczestniczyli w identycznych sesjach edukacyjnych, które obejmowały definicje i wzorce ZS, konsekwencje zdrowotne ZS oraz strategie przerywania długotrwałych okresów siedzenia i redukcji całkowitego czasu ZS. Przykłady metod redukcji ZS były dostosowane do wieku uczestników – np. dzieci otrzymywały wskazówki dotyczące redukcji ZS podczas pobytu w szkole (Kulis i in., 2024; Szczuka i in., 2024). W badaniu nie stosowano technik zmiany zachowania związanych z satysfakcją z relacji ani kontrolą społeczną.

Badanie 2 miało charakter podłużny i trwało 8 miesięcy. Podczas pierwszego pomiaru (T1) zebrano dane za pomocą kwestionariuszy (dotyczące kontroli społecznej związanej z ZS oraz poziomu satysfakcji z relacji), a także rejestrowano czas ZS za pomocą akcelerometrów przez 6 dni. Drugi pomiar (T2), wykonany 2 miesiące po T1, polegał na zebraniu danych kwestionariuszowych. Pomiar trzeci (T3), przeprowadzony po 8 miesiącach od T1, polegał na zebraniu danych akcelerometrycznych. Wszystkie dane były zbierane indywidualnie – rodzice i dzieci wypełniali kwestionariusze oddzielnie podczas spotkań z eksperymentatorem.

Dane zbierano od lutego 2016 do marca 2022 w 18 lokalizacjach miejskich i dziewięciu lokalizacjach wiejskich w południowo-zachodniej Polsce. Uczestnicy byli rekrutowani w szkołach podczas zebrań z rodzicami, za pośrednictwem mediów społecznościowych oraz na stronach internetowych organizacji pozarządowych. Potencjalnym uczestnikom przekazywano szczegółowe informacje o celach i procedurach badania. Po zapoznaniu się z materiałami informacyjnymi kandydaci byli weryfikowani pod kątem spełnienia kryteriów włączenia. Rodzice i dzieci byli proszeni o wyrażenie świadomej zgody na udział w badaniu; uzyskano również zgodę rodziców na udział dziecka w badaniu. Badanie zostało zatwierdzone przez Komisję Etyczną Badań Naukowych Uniwersytetu SWPS.

Osoby badane

Do badania zrekrutowano $N = 247$ diad rodzic-dziecko. Pomiar w czasie T3 (8 miesięcy po T1) został ukończony przez $n = 176$ diad, co oznacza, że odsetek rezygnacji wyniósł 28,74%. Kryteria włączenia obejmowały: (1) wiek dziecka od 10 do 14 lat (uczeń 4-8 klasy szkoły podstawowej); jednak aby zapobiec potencjalnemu poczuciu wykluczenia wśród dzieci w tej samej klasie szkolnej, włączono również uczestników, którzy mieli 9 lat ($n = 11$) lub 15 lat ($n = 2$); (2) zgodnie z deklaracją rodziców podczas rekrutacji (T1), poziom aktywności fizycznej (AF) dziecka przed przystąpieniem do badania był poniżej progów wskazanych przez Światową Organizację Zdrowia (WHO, 2010; 2020); (3) dzieci i rodzice wyrazili chęć zwiększenia swojej AF.

Początkowa próba rodziców lub opiekunów prawnych (85,8 % kobiet) miała od 29 do 66 lat ($M = 41,00$ lat; $SD = 4,87$). W badaniu uczestniczył ten rodzic, który spędzał więcej czasu z dzieckiem. Dzieci (48,6 % dziewczyn) miały od 9 do 15 lat ($M = 11,37$ lat; $SD = 1,22$). Dzieci w wieku 9 lat ($n = 11$), które uczestniczyły w badaniu, wykazywały

zaawansowany rozwój poznawczy i społeczny (dojrzałość szkolna oceniana podczas zapisów do pierwszej klasy) i rozpoczęły formalną edukację wcześniej niż ich rówieśnicy.

Wśród dzieci 57,9 % miało prawidłową masę ciała (według kryteriów International Obesity Task Force [IOTF]; Cole i Lobstein, 2012), 38,9 % miało nadwagę lub otyłość, a 3,2 % miało niedowagę. W przypadku rodziców 56,7 % miała nadwagę lub otyłość, 40,5 % rodziców miało prawidłową masę ciała, a 2,8 % niedowagę.

Narzędzia

Zachowania Siedzące (T1, T3). Por. opis Badania 1. Czas ZS obliczano jako średnią liczbę minut zachowań siedzących na każdy dzień noszenia urządzenia, skorygowaną o liczbę godzin noszenia akcelerometru.

Postrzegana Pozytywna i Negatywna Kontrola Społeczna (T1 i T2). Por. opis Badania 1. W przeciwieństwie do podejścia zastosowanego w Badaniu 1, gdzie obie osoby w diadzie odpowiadały na pytania dotyczące postrzeganych technik kontroli społecznej stosowanych przez drugą stronę, w diadach rodzic–dziecko rodzice odpowiadali na pytania dotyczące technik kontroli społecznej, które sami stosowali, natomiast dzieci opisywały, jak tę kontrolę postrzegały.

Satysfakcja z Relacji (T1 i T2). Do pomiaru satysfakcji z relacji wykorzystano czteroelementową wersję Indeksu Satysfakcji ze Związku (CSI-4; Funk i Rogge, 2007). Dzieci i ich rodzice oceniali swoje wzajemne relacje, odpowiadając na następujące pytania: „Proszę, wskaż poziom szczęścia, uwzględniając wszystkie aspekty, w relacji z Twoim dzieckiem/rodzicem", „Moje dziecko czuje się bezpiecznie ze mną i wie, że może na mnie liczyć"/ „Czuję się bezpiecznie z moim rodzicem i wiem, że mogę na niego liczyć", z odpowiedziami w skali od 1 (*zdecydowanie się zgadzam*) do 4 (*zdecydowanie się nie zgadzam*); „Jak satysfakcjonująca jest twoja relacja z dzieckiem/rodzicem?", z

odpowiedziami w skali od 1 (*wcale*) do 4 (*całkowicie*); „Ogólnie, jak bardzo jesteś zadowolony/a ze swojej relacji?" z odpowiedziami w skali od 1 (*wcale*) do 4 (*całkowicie*).

Zmienne kontrolne. Kowarianty socjodemograficzne wykorzystane w analizie wrażliwości obejmowały: (1) wiek; (2) płeć; (3) wykształcenie rodzica (podstawowe, zawodowe, średnie, policealne, licencjat, magisterskie); (4) samooceniany status ekonomiczny rodzica, z odpowiedziami w skali od 1 (*znacznie powyżej przeciętnej rodziny* w *Polsce*) do 5 (*znacznie poniżej przeciętnej rodziny w Polsce*). Intencja zmniejszenia czasu ZS została oceniona w T1 za pomocą dwóch stwierdzeń (Maher i Conroy, 2015): „Zamierzam siedzieć maksymalnie 5 godzin (łącznie) dziennie przez następny tydzień" oraz „Zamierzam przerywać swoje zachowanie siedzące co najmniej raz na godzinę." Odpowiedzi mieściły się w skali od 1 (*zdecydowanie nie*) do 4 (*zdecydowanie tak*).

Analiza danych

Por. opis Badania 1

Wyniki Badania 2

Wyniki dla modelu „Kontrola Społeczna → Satysfakcja z Relacji→ ZS"

Zakładany model, obliczony dla $N = 247$ diad, charakteryzował się adekwatnymi wskaźnikami dopasowania do danych: $\chi^2(42) = 47{,}758$, $p = 0{,}250$, $\chi^2/df = 1{,}137$, NFI = 0,960, CFI = 0,995, RMSEA = 0,024 (90% CI: 0,000, 0,051). Zmienne w modelu wyjaśniały 26,6% wariancji czasu ZS dzieci (T3) oraz 43,7% czasu ZS rodziców (T3). Bezpośrednie i pośrednie zależności między zmiennymi niezależnymi (T1), mediatorami (T2) oraz zmiennymi zależnymi (T3), a także główne wyniki przedstawiono na Rycinie 3.

Analiza ścieżkowa modelu wykazała trzy istotne efekty pośrednie. Wyższy poziom pozytywnej kontroli społecznej rodziców, postrzeganej przez dzieci (T1), był związany z wyższym poziomem satysfakcji z relacji u dzieci (T2), co z kolei wyjaśniało krótszy czas ZS u rodziców (T3); $b = -6{,}631$, $SE = 2{,}720$, 95 % CI [-12,973, -2,056], $p = 0{,}006$. Wyższy

poziom pozytywnej kontroli społecznej rodziców, postrzeganej przez dzieci (T1), był związany z wyższym poziomem satysfakcji z relacji u rodziców (T2), co z kolei wyjaśniało dłuższy czas ZS u rodziców (T3); b = 5,793, SE = 2,297, 95 % CI [2,095, 11,319], p = 0,002. Niższy poziom kontroli negatywnej stosowany przez rodziców (T1) wyjaśniał wyższy poziom satysfakcji z relacji u rodziców (T2); co z kolei wyjaśniało wyższy poziom ZS u rodziców (T3); b = - 3,630, SE = 2,069, 95 % CI [-8,646, -0,358], p = 0,026.

Analiza wrażliwości, uwzględniająca płeć, wiek dzieci i rodziców, wykształcenie rodzica oraz jego status ekonomiczny, intencję do redukcji ZS (T1) u dzieci i rodziców, przypisanie do grupy eksperymentalnej (1 = interwencja planowania AF, 0 = brak interwencji planowania) oraz czas noszenia akcelerometru, wykazała wzorce efektów zgodne z wynikami w modelu podstawowym.

Wyniki dla modelu „Satysfakcja z Relacji → Kontrola Społeczna→ ZS”

Zakładany model, obliczony dla N = 247 diad, charakteryzował się akceptowalnymi wskaźnikami dopasowania do danych: $\chi^2(42) = 52{,}077$, p = 0,137, χ^2/df = 1,240, NFI = 0,952, CFI = 0,990, RMSEA = 0,031 (90 % CI: 0,000, 0,056). Zmienne w modelu wyjaśniały 25,8% wariancji czasu ZS dzieci (T3) oraz 40,9 % czasu ZS rodziców (T3). Nie zaobserwowano żadnych istotnych efektów pośrednich. Związki między zmiennymi niezależnymi (T1), mediatorami (T2) oraz zmiennymi zależnymi (T3), a także główne wyniki przedstawiono na Rycinie 4.

Analiza wrażliwości, uwzględniająca płeć, wiek dzieci i rodziców, wykształcenie rodzica oraz jego status ekonomiczny, intencję do redukcji ZS (T1) u dzieci i rodziców, przypisanie do grupy eksperymentalnej (1 = interwencja planowania PA, 0 = brak interwencji planowania) oraz czas noszenia akcelerometru, wykazała wzorce efektów zgodne z wynikami w modelu podstawowym.

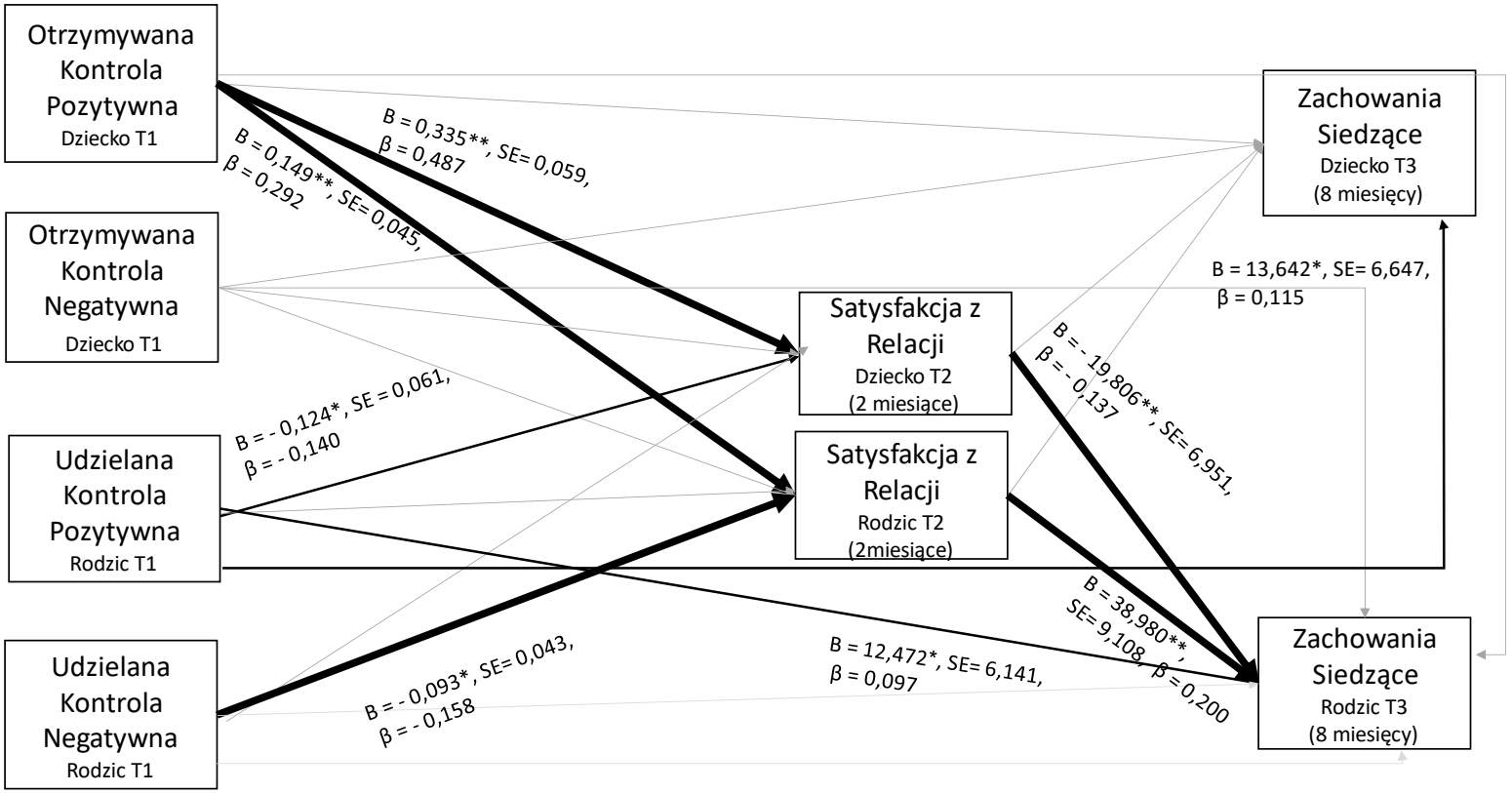
Dyskusja wyników Badania 2

Badanie 2 koncentrowało się na diadach rodzic-dziecko uczestniczących w interwencji mającej na celu zwiększenie aktywności fizycznej (AF). Wyniki wskazały na złożone zależności między stosowaniem przez rodziców oraz postrzeganiem przez dzieci technik kontroli społecznej, satysfakcją z relacji u dzieci i rodziców, a także czasem spędzonym na zachowaniach siedzących. Stosowanie pozytywnej kontroli przez rodziców (zgłaszane przez rodziców:T1) było bezpośrednio związane z wyższym poziomem ZS u dzieci i rodziców (T3). Wyższy poziom satysfakcji z relacji u rodziców (T1, T2) wyjaśniał wyższy poziom ZS u rodziców w T3. Z kolei wyższa satysfakcja z relacji u dzieci (T2) była związana z niższym poziomem ZS u rodziców w T3.

Dodatkowo, wyniki dotyczące pozytywnej kontroli społecznej wykazały kolejne złożoności zależne od perspektywy – stosowania kontroli przez rodziców lub jej postrzegania przez dzieci. Relacje dzieci dotyczące postrzeganej pozytywnej kontroli (T1) wyjaśniały wyższą satysfakcję z relacji zarówno u dzieci, jak i rodziców (T2). Jednocześnie częstsze stosowanie pozytywnej kontroli przez rodziców (T1) było związane z niższą satysfakcją z relacji u dzieci (T2), co sugeruje, że mogły być zaangażowane różne strategie pozytywnej kontroli społecznej w przypadku tych dwóch przeciwnych efektów. Wyniki podkreślają znaczenie perspektywy w ocenie technik kontroli społecznej oraz ich potencjalne oddziaływanie na wzorce ZS w diadach rodzic-dziecko.

Rycina 3.

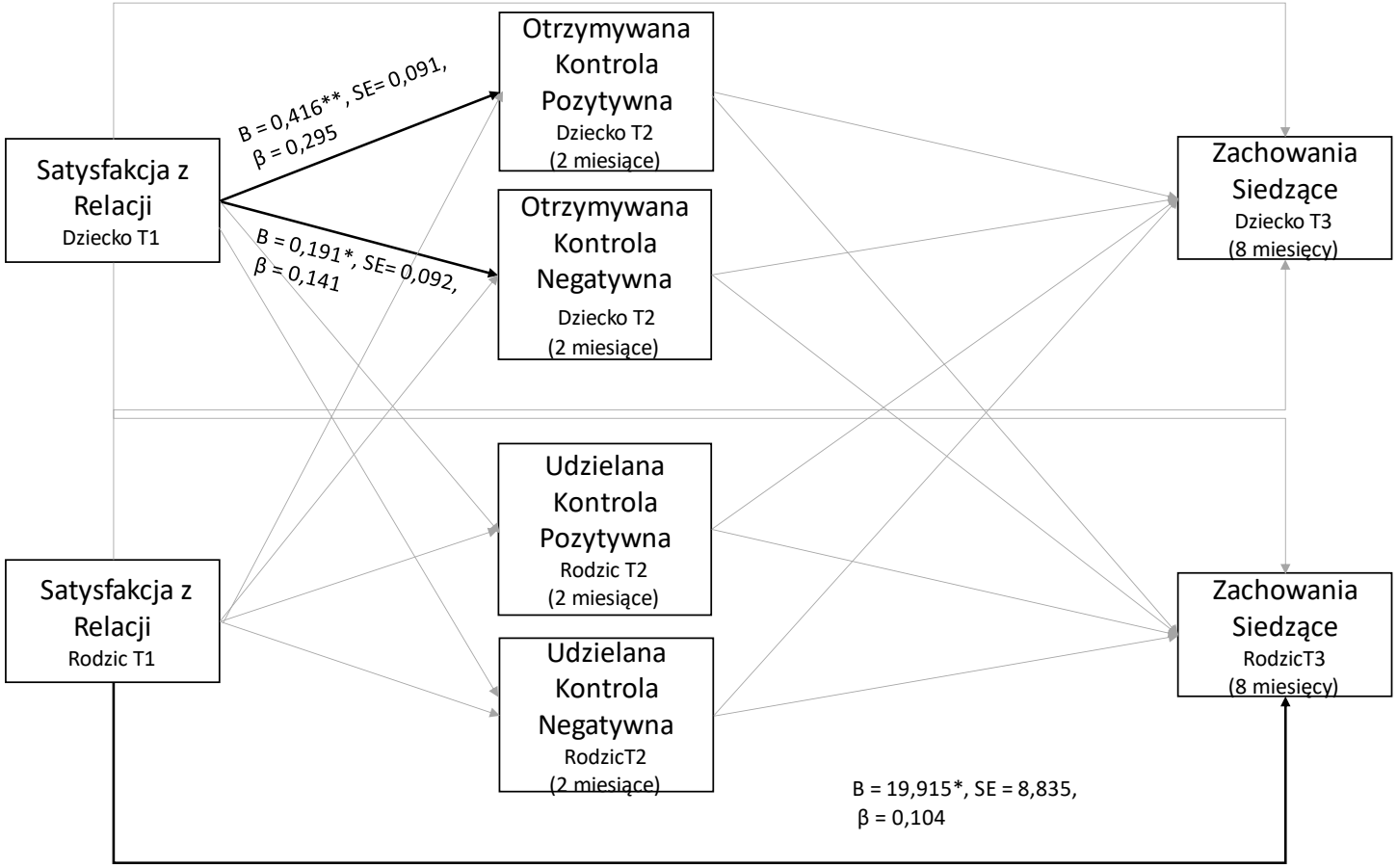
Bezpośrednie i pośrednie efekty dla modelu „ Kontrola Społeczna → Satysfakcja z Relacji → Zachowania Siedzące”



Nota. ** $p < 0{,}01$; * $p < 0{,}05$. Istotne efekty zaznaczono liniami ciągłymi. Istotne efekty pośrednie oznaczono pogrubionymi liniami. Szare linie reprezentują efekty bezpośrednie, które nie były istotne. T1 = Pomiar 1, punkt wyjściowy; T2 = Pomiar 2, 8 tygodni po T1; T3 = Pomiar 3, 8 miesięcy po T1. Założono, że reszty wszystkich predyktorów, mediatorów i zmiennych wynikowych są skorelowane (dla przejrzystości nie przedstawiono kowariancji na Rycinie). Model kontrolował poziom zachowań siedzących w T1 (nie przedstawiono dla przejrzystości Ryciny).

Rycina 4.

Bezpośrednie i pośrednie efekty dla modelu „Satysfakcja z Relacji → Kontrola Społeczna → Zachowania Siedzące”



Nota. ** $p < 0{,}01$; * $p < 0{,}05$. Istotne efekty zaznaczono liniami ciągłymi. Istotne efekty pośrednie oznaczono pogrubionymi liniami. Szare linie reprezentują efekty bezpośrednie, które nie były istotne. T1 = Pomiar 1, punkt wyjściowy; T2 = Pomiar 2, 8 tygodni po T1; T3 = Pomiar 3, 8 miesięcy po T1. Założono, że reszty wszystkich predyktorów, mediatorów i zmiennych wynikowych są skorelowane (dla przejrzystości nie przedstawiono kowariancji na Rycinie). Model kontrolował poziom zachowań siedzących w T1 (nie przedstawiono dla przejrzystości Ryciny).

Badanie 3

(por. Siwa i in., 2023b)

Cel Badania 3

Oprócz dobrze udokumentowanych powiązań między zachowaniami siedzącymi a wskaźnikami zdrowia somatycznego (Patterson i in., 2018), coraz więcej dowodów wskazuje na istotne zależności między dłuższym czasem spędzanym na siedzeniu a negatywnymi wynikami zdrowia psychicznego, takimi jak wyższy poziom lęku (Stanczykiewicz i in., 2019) czy gorsza jakość życia (Boberska i in., 2018). Objawy depresji są jednym z najczęściej badanych wskaźników zdrowia psychicznego w kontekście zależności między ZS a zdrowiem psychicznym (Hallgren i in., 2020). Wynika to między innymi z wysokiej częstości występowania depresji, dotykającej od 7 % do 20 % populacji w ciągu życia (Lim i in., 2019). Ograniczona skuteczność istniejących terapii depresji podkreśla potrzebę lepszego zrozumienia behawioralnych czynników związanych zarówno z występowaniem depresji, jak i jej konsekwencjami, które mogą zwiększać ryzyko nawrotu choroby (Hallgren i in., 2020).

Istnieje wiele modeli sugerujących wewnątrzosobowe zależności między zachowaniami siedzącymi a objawami depresji. Jednak charakter tych powiązań pozostaje niejasny. Dotychczasowe badania zazwyczaj testowały zależności przekrojowe lub wewnątrz-jednostkowe między czasem siedzenia a poziomem objawów depresji. Mnogość badań opartych na samoocenie ZS kontrastuje z brakiem badań wykorzystujących akcelerometry do oceny czasu siedzenia. Dowody na zależności między jednostkami w dalszym ciągu są bardzo ograniczone. Brak jest empirycznych dowodów na kolejność powiązań między zachowaniami siedzącymi a objawami depresji w diadach dorosłych.

Aby wypełnić tę lukę, w niniejszym badaniu przetestowano dwa hipotetyczne modele zakładające międzyjednostkowe efekty krzyżowe w diadach składających się z osoby docelowej i jej partnera. Pierwszy model sprawdzał, czy zachowania siedzące osób

docelowych i ich partnerów (Pomiar 1; T1) wyjaśniają objawy depresji u drugiej osoby w diadzie (mierzone w Pomiarze 2, T2; 8 miesięcy po T1), które z kolei wyjaśniają wzajemne zachowania siedzące oceniane w Pomiarze 3 (T3, 14 miesięcy po T1). Drugi model analizował, czy poziom objawów depresji u osób docelowych i ich partnerów w T1 wyjaśnia wzajemne zachowania siedzące w T2, które z kolei wyjaśniają wzajemne objawy depresji w T3.

Metoda Badania 3

Procedura badania

Por. opis Badania 1. Badanie 3 miało charakter podłużny i trwało 14 miesięcy. W każdym pomiarze zostały zmierzone symptomy depresji za pomocą kwestionariuszy oraz czas ZS przy użyciu akcelerometrów w 6-dniowych pomiarach. Drugi pomiar (T2) został przeprowadzony 8 miesięcy po T1, natomiast pomiar trzeci (T3) po 14 miesiącach od T1.

Osoby badane

Por. opis Badania 1. W pierwszym pomiarze uczestniczyło 320 diad dorosłych, składających się z osoby docelowej i jej partnera (320 osób badanych i 320 partnerów). Pomiar trzeci (14 miesięcy po T1) został ukończony przez $n = 270$ osób badanych i $n = 270$ partnerów, co oznacza, że w trakcie trwania badania z udziału zrezygnowało jedynie 15,6% uczestników.

Narzędzia

Zachowania Siedzące (T1, T2, T3). Por. opis Badania 1. Czas ZS obliczano jako średnią liczbę minut spędzonych na siedzeniu w ciągu dnia, skorygowaną o liczbę godzin noszenia urządzenia.

Objawy Depresji (T1, T2, T3). Do oceny nasilenia objawów depresyjnych zastosowano Kwestionariusz Zdrowia Pacjenta-9 (PHQ-9; Kroenke i in., 2001). Pytania w kwestionariuszu odpowiadają kryteriom depresji według DSM-IV. Uczestnicy oceniali

częstotliwość występowania każdego z objawów w ciągu ostatnich dwóch tygodni na skali od 0 do 3 (0 – *wcale*, 1 – *kilka dni*, 2 – *więcej niż połowa dni*, 3 – *niemal codziennie*). Wynik < 5 wskazuje brak depresji, wynik od 5 do 9 oznacza łagodną depresję, 10–14 wskazuje umiarkowaną depresję, 15–19 – umiarkowanie ciężką depresję, a wynik > 20 oznacza ciężką depresję (Kroenke i in., 2001).

Zmienne kontrolne. Minuty umiarkowanej do intensywnej aktywności fizycznej osób docelowych i ich partnerów na dzień (T1) zostały zmierzone za pomocą akcelerometrów ActiGraph wGT3X-BT, z wykorzystaniem algorytmu Sasaki i in. (2011). Codzienne minuty umiarkowanej do intensywnej aktywności fizycznej dla każdego dnia z ważnym czasem noszenia (z wyłączeniem pierwszego dnia) były sumowane i dzielone przez liczbę ważnych dni noszenia.

Kowarianty socjodemograficzne wykorzystane w analizach wrażliwości obejmowały: (1) wiek; (2) płeć; (3) wykształcenie (podstawowe, zawodowe, średnie, policealne, licencjat, magisterskie, inne); (4) samoopisywany status społeczno-ekonomiczny, z odpowiedziami w zakresie od 1 (*znacznie powyżej przeciętnej rodziny w Polsce*) do 5 (*znacznie poniżej przeciętnej rodziny w Polsce*); (5) typ relacji (związek romantyczny = 1, w porównaniu do innych, tj. bliskie relacje rodzinne, bliskie przyjaźnie, relacje zawodowe = 0); (6) diagnoza choroby przewlekłej (np. choroby sercowo-naczyniowe, cukrzyca lub układu mięśniowo-szkieletowego = 1, brak = 0).

Analiza danych

Por. opis Badania 1.

Wyniki Badania 3

Wyniki dla modelu „ZS → Objawy Depresji → ZS”

Zakładany model, obliczony dla $N = 320$ diad, charakteryzował się adekwatnymi wskaźnikami dopasowania do danych: $\chi^2(6) = 12{,}70$, $p = 0{,}048$, $\chi^2/df = 2{,}116$, NFI = 0,981,

CFI = 0,989, RMSEA = 0,059 (90 % CI [0,005, 0,105]). Zmienne w modelu wyjaśniały 46,3 % wariancji zachowań siedzących osób docelowych (T3) oraz 42,0 % wariancji zachowań siedzących partnerów (T3). Zależności między zmiennymi niezależnymi (T1), mediatorami (T2) i zmiennymi zależnymi (T3), a także główne wyniki przedstawiono na Rycinie 5. W celu kontrolowania potencjalnie zakłócających efektów aktywności fizycznej, w modelu uwzględniono zależności między umiarkowaną do intensywnej aktywnością fizyczną (MVPA) osób docelowych i partnerów (T1) a odpowiednimi zmiennymi niezależnymi i mediacyjnymi. Analiza wykazała jeden istotny efekt pośredni. Dłuższy czas ZS wśród partnerów (T1) był związany z wyższym poziomem objawów depresji u osób docelowych (T2), co z kolei wyjaśniało dłuższy czas siedzenia wśród partnerów (T3). Współczynnik efektu pośredniego był istotny, b = 0,010, SE = 0,113, 95 % CI [0,001, 0,032], p = 0,034.

Analiza wrażliwości, kontrolująca zmienne socjodemograficzne (T1), takie jak płeć, wiek, wykształcenie, postrzegany status ekonomiczny osób badanych i partnerów, diagnoza choroby przewlekłej u obu osób (1 = z chorobą przewlekłą vs. 0 = bez choroby przewlekłej), typ relacji (1 = romantyczna vs. 0 = inna) oraz efekty przypisania do grupy eksperymentalnej, potwierdziła efekty bezpośrednie i pośredni zgodne z uzyskanymi w modelu podstawowym.

Wyniki dla modelu „Objawy Depresji → ZS → Objawy Depresji”

Zakładany model, obliczony dla N = 320 diad, charakteryzował się adekwatnym dopasowaniem do danych: $\chi^2(8) = 17{,}73$, p = 0,023, $\chi^2/df = 2{,}117$, NFI = 0,956, CFI = 0,974, RMSEA = 0,062 (90 % CI [0,022, 0,101]). Zmienne w modelu wyjaśniały 41,6 % wariancji objawów depresji osób docelowych (T3) oraz 33,0 % wariancji objawów depresji partnerów (T3). Zależności między zmiennymi niezależnymi (T1), mediatorami (T2) i zmiennymi zależnymi (T3), a także główne wyniki przedstawiono na Rycinie 6. W celu kontrolowania potencjalnie zakłócających efektów aktywności fizycznej, w modelu uwzględniono

zależności między umiarkowaną do intensywnej aktywnością fizyczną (MVPA) osób docelowych i partnerów (T1) a odpowiednimi zmiennymi niezależnymi i mediacyjnymi. W modelu nie zaobserwowano żadnych istotnych efektów pośrednich.

Analiza wrażliwości, kontrolująca płeć, wiek, wykształcenie, postrzegany status ekonomiczny osób badanych i partnerów, obecność choroby przewlekłej u obu osób (1 = z chorobą przewlekłą vs. 0 = brak choroby), typ relacji (1 = romantyczna vs. 0 = inna) oraz efekty przypisania do grupy eksperymentalnej, potwierdziła, że efekty bezpośrednie były zgodne z wynikami, uzyskanymi w modelu podstawowym.

Dyskusja wyników Badania 3

Wyniki tego badania należą do pierwszych, które testują długoterminowe zależności między zachowaniami siedzącymi, mierzonymi za pomocą akcelerometru, a objawami depresji w kontekście diad. Jest ono również nowatorskie, ponieważ analizuje te zależności w grupie szczególnie narażonej na ryzyko – osoby badane nie były wystarczająco aktywne fizycznie, miały intencję ograniczenia zachowań siedzących lub zwiększenia aktywności fizycznej, a także charakteryzowały się nadwagą, otyłością, chorobami sercowo-naczyniowymi lub innymi przewlekłymi schorzeniami.

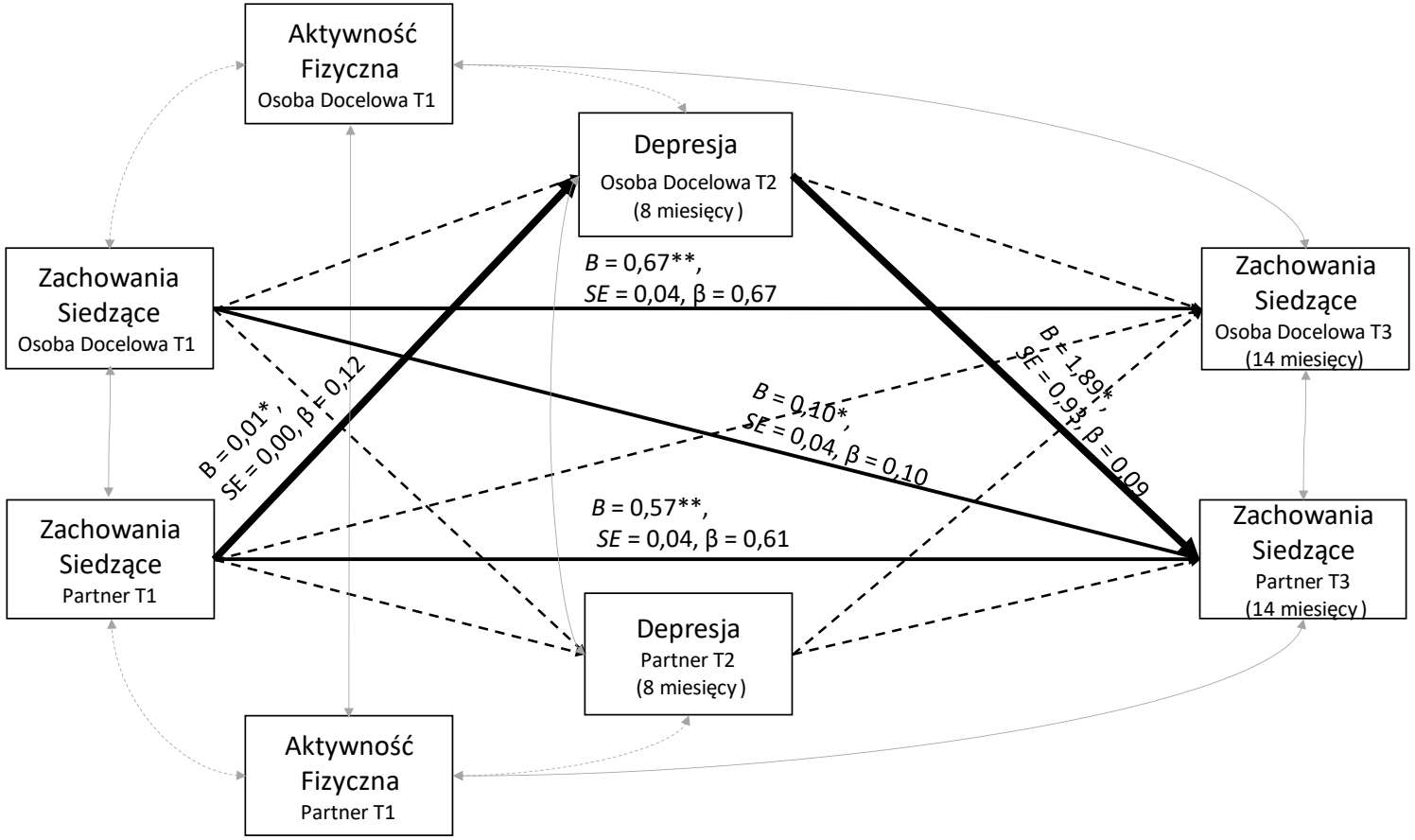
Wyniki wykazały spójne dodatnie zależności podłużne między objawami depresji osób docelowych a zachowaniami siedzącymi partnerów, zarówno w relacjach T1 -> T2, jak i dla T2 -> T3. Z kolei odwrotne zależności, w których objawy depresji partnerów wyjaśniały zachowania siedzące osób docelowych, nie były istotne statystycznie. Może to wynikać ze specyfiki włączonych diad. Osoby docelowe wykazywały wyższy poziom objawów depresji, a także były bardziej narażone na nadwagę, otyłość czy zdiagnozowaną chorobę przewlekłą, co mogło kształtować dynamikę tych relacji.

Zaobserwowane w badaniu efekty bezpośrednie oraz jeden istotny efekt pośredni częściowo potwierdzają hipotezę błędnego koła między zachowaniami siedzącymi a depresją,

jak sugerowano w badaniach Hallgrena i in. (2020). Szczególnie dotyczy to sytuacji, w których osoba docelowa ma podwyższony poziom objawów depresji na początku badania i/lub jest bardziej narażona na depresję z powodu innych czynników ryzyka. W takich przypadkach partner często przyjmuje rolę „osoby wspierającej," co może wpływać na jego własne wzorce zachowań siedzących w odpowiedzi na symptomy depresji osoby docelowej. Wyniki badania wnoszą istotny wkład w zrozumienie złożonej dynamiki między zachowaniami zdrowotnymi a zdrowiem psychicznym w bliskich relacjach międzyludzkich, otwierając nowe perspektywy dla przyszłych badań w tym obszarze.

Rycina 5.

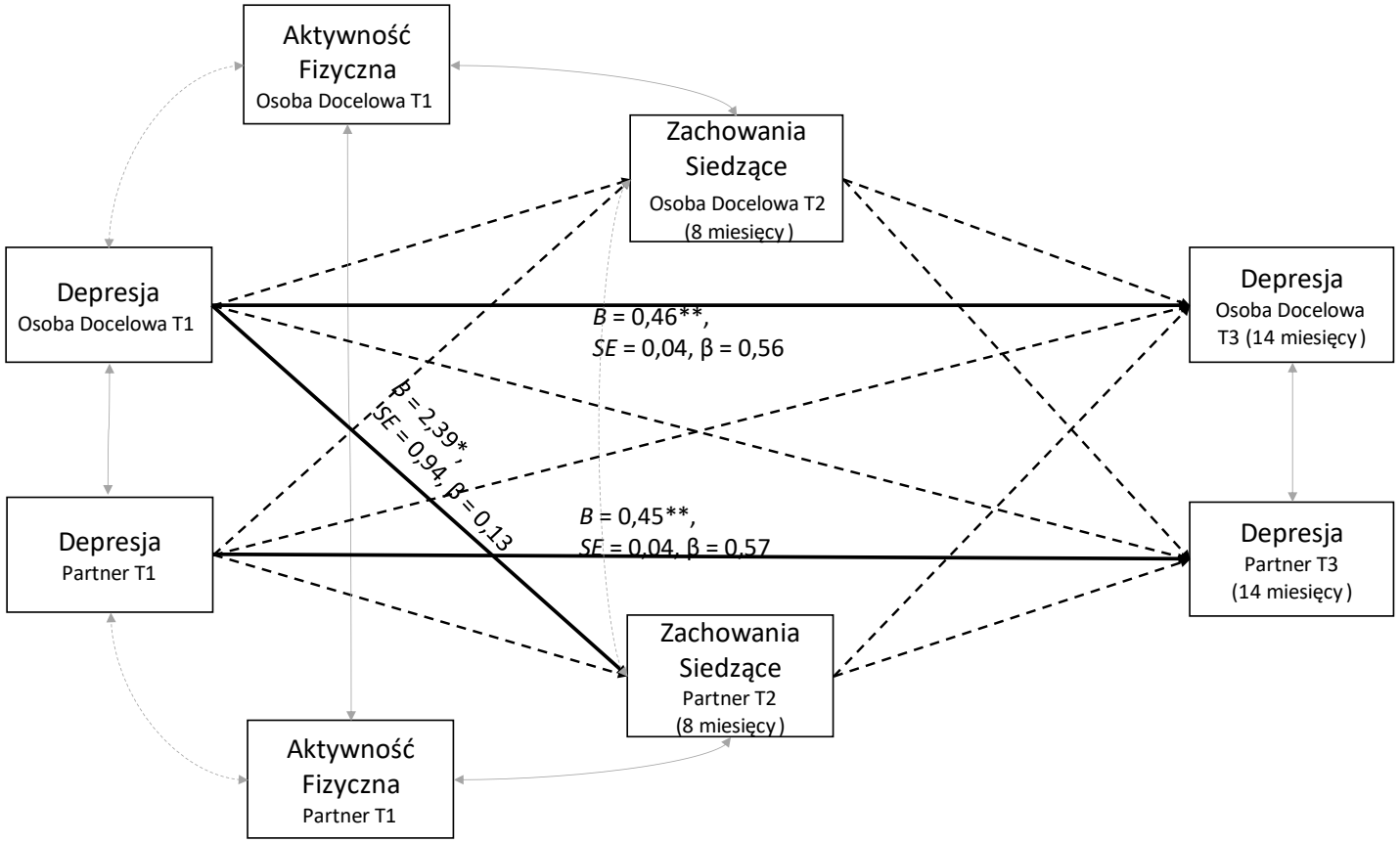
Bezpośrednie i pośrednie efekty dla modelu „Zachowania Siedzące → Objawy Depresji → Zachowania Siedzące”



Nota. ** $p < 0{,}01$; * $p < 0{,}05$.Istotne efekty zaznaczono liniami ciągłymi. Istotne efekty pośrednie oznaczono pogrubionymi liniami. Czarne linie oznaczają efekty bezpośrednie, a szare linie oznaczają kowariancje. Przerywane linie reprezentują efekty bezpośrednie, które nie były istotne. Założono kowariancję reszt wskaźników objawów depresyjnych w T2 oraz wskaźników zachowań siedzących w T3. Depresja = objawy depresji; Aktywność fizyczna = minuty umiarkowanej do intensywnej aktywności fizycznej; T1 = Czas 1, punkt wyjściowy; T2 = Czas 2, 8 miesięcy po T1; T3 = Czas 3, 14 miesięcy po T1.

Rycina 6.

Bezpośrednie i pośrednie efekty dla modelu „Objawy Depresji → Zachowania Siedzące → Objawy Depresji”



Nota. ** $p < 0{,}01$; * $p < 0{,}05$.Istotne efekty zaznaczono liniami ciągłymi. Istotne efekty pośrednie oznaczono pogrubionymi liniami. Czarne linie oznaczają efekty bezpośrednie, a szare linie oznaczają kowariancje. Przerywane linie reprezentują efekty bezpośrednie, które nie były istotne. Założono kowariancję reszt wskaźników zachowań siedzących w T2 oraz wskaźników symptomów depresji w T3. Depresja = objawy depresji; Aktywność fizyczna = minuty umiarkowanej do intensywnej aktywności fizycznej; T1 = Czas 1, punkt wyjściowy; T2 = Czas 2, 8 miesięcy po T1; T3 = Czas 3, 14 miesięcy po T1.

Badanie 4

(por. Siwa i in., 2024b)

Cel badania 4

Celem Badania 4 było zbadanie podłużnych efektów bezpośrednich i pośrednich (mediacyjnych) łączących objawy depresji i czas spędzony na zachowaniach siedzących (ZS), zarówno na poziomie indywidualnym, jak i międzyosobowym, w diadach rodzic-dziecko. W ramach badania wykorzystano dwa hipotetyczne modele do analizy efektów krzyżowych (od jednej osoby do drugiej) w relacjach między rodzicami a dziećmi. Pierwszy model zakładał, że (1) zachowania siedzące rodziców i dzieci (Pomiar 1; T1) będą wyjaśniać wzajemnie swoje objawy depresji (mierzone w Pomiarze 2, T2; 8 miesięcy po T1), które z kolei będą wyjaśniać wzajemne zachowania siedzące oceniane w Pomiarze 3 (T3, 14 miesięcy po T1). Drugi model zakładał, że objawy depresji rodziców i dzieci podczas T1 będą wyjaśniać wzajemne zachowania siedzące w T2, które z kolei będzie wyjaśniać wzajemne objawy depresji w T3. Pytania badawcze postawione w Badaniu 4 są analogiczne do tych, które analizowano w Badaniu 3, jednak uwzględniają specyfikę relacji rodzic–dziecko.

Dotychczasowe badania nad zależnościami pomiędzy ZS a symptomami depresji przyniosły ambiwalentne rezultaty. Z jednej strony niektóre badania sugerują, że wyższy poziom objawów depresji może być powiązany z dłuższym czasem siedzenia w obserwacjach podłużnych na poziomie indywidualnym (Hallgren i in., 2020; Hamer i Smith, 2023; Zou i in., 2024). Z drugiej strony istnieją dowody wskazujące, że niższy poziom negatywnych emocji może wiązać się z dłuższym czasem siedzenia wśród rodziców (np. Yang i in., 2020). Badanie 4 ma na celu wypełnienie tej luki, analizując szczegółowo wzajemne powiązania między zachowaniami siedzącymi a objawami depresji w diadach rodzic–dziecko na przestrzeni czasu.

Metoda Badania 4

Procedura badania

Por. opis Badania 2. Badanie 4 miało charakter podłużny i trwało 14 miesięcy. W każdym z trzech pomiarów oceniano symptomy depresji za pomocą kwestionariuszy oraz ZS przy użyciu akcelerometrów w 6-dniowych pomiarach. Drugi pomiar (T2) przeprowadzono 8 miesięcy po T1, natomiast pomiar trzeci (T3) odbył się po 14 miesiącach od T1.

Osoby badane

Początkowa próba obejmowała $N = 247$ diad rodzic-dziecko, z których 44 zostały wykluczone z analiz ze względu na brak zgłaszanych objawów depresji u rodzica lub dziecka w T1. Ostateczna analiza objęła $N = 203$ diady rodzic-dziecko. Pomiar 3 (po 14 miesiącach) został ukończony przez $n = 129$ diad, co wskazuje na wskaźnik rezygnacji z badania wynoszący 36,5%.

W próbie rodziców podczas T1 dominowały kobiety (86,7 %), w wieku od 29 do 66 lat ($M = 40,85$ lat; $SD = 4,77$). U 59,6 % rodziców zaobserwowano nadwagę lub otyłość, 34,0% miało prawidłową masę ciała, a 6,4 % miało niedowagę. Dzieci uczestniczące w badaniu (48,8 % dziewczyn) miały od 9 do 15 lat ($M = 11,41$ lat; $SD = 1,26$). Dziewięciolatki ($n = 10$), które wzięły udział w badaniu, rozpoczęły formalną edukację w młodszym wieku niż ich rówieśnicy. Wśród dzieci 54,7 % miało prawidłową masę ciała według kryteriów IOTF (Cole i Lobstein, 2012), 42,3 % miało nadwagę lub otyłość, a 3,0 % niedowagę.

Narzędzia

Zachowania Siedzące (T1, T2, T3). Por. opis Badania 1

Objawy Depresji (T1, T2, T3). Por. opis Badania 3

Zmienne kontrolne. Por. opis Badania 3. Kowarianty socjodemograficzne wykorzystane w analizie wrażliwości obejmowały: (1) wiek; (2) płeć; (3) wykształcenie rodzica (podstawowe, zawodowe, średnie, policealne, licencjat, magisterskie); (4)

samooceniany status ekonomiczny rodzica, z odpowiedziami w skali od 1 (*znacznie powyżej przeciętnej rodziny w Polsce*) do 5 (*znacznie poniżej przeciętnej rodziny w Polsce*).

Analiza danych

Por. opis Badania 1

Wyniki Badania 4

Wyniki dla modelu „ZS → Objawy Depresji → ZS"

Zakładany model, obliczony dla $N = 203$ diad cechował się adekwatnymi wskaźnikami dopasowania do danych : $\chi^2(6) = 12{,}44$, $p = 0{,}053$, $\chi^2/df = 2{,}073$, NFI = 0,978, CFI = 0,988, RMSEA = 0,073. Zmienne w modelu wyjaśniały 41,5 % wariancji ZS u dzieci (T3) oraz 37,5 % ZS u rodziców (T3). Zależności między zmiennymi niezależnymi (T1), mediatorami (T2) i zmiennymi zależnymi (T3), a także główne wyniki przedstawiono na Rycinie 7. W celu wyeliminowania potencjalnie zakłócających efektów aktywności fizycznej w modelu uwzględniono zależności między umiarkowaną do intensywnej aktywnością fizyczną (MVPA) rodziców i dzieci (T1) a odpowiednimi zmiennymi niezależnymi i mediacyjnym. Analiza modelu wykazała jeden istotny efekt pośredni ($b = -0{,}024$, $SE = 0{,}014$, 95 % CI [-0,065, -0,005], $p = 0{,}010$.). Wynik ten wskazywał, że wyższy poziom ZS u dzieci (T1) był związany z wyższym poziomem objawów depresji zgłaszanym przez dzieci (T2), co z kolei wyjaśniało krótszy czas ZS u dzieci (T3).

Analiza wrażliwości, uwzględniająca zmienne socjodemograficzne (T1), takie jak płeć, wiek, wykształcenie rodziców, postrzegany status ekonomiczny rodziców oraz efekty przypisania do grupy eksperymentalnej, potwierdziła, że efekty bezpośrednie i pośredni były zgodne z wynikami uzyskanymi w modelu podstawowym.

Wyniki dla modelu „Objawy Depresji → ZS → Objawy Depresji"

Zakładany model, obliczony dla N = 320 diad, posiadał następujące wskaźniki, świadczące o akceptowalnym dopasowaniu do danych: $\chi^2(8) = 14{,}10$, $p = 0{,}079$, $\chi^2/df =$

1,762, NFI = 0,956, CFI = 0,979, RMSEA = 0,061. Zmienne w modelu wyjaśniały 27,0 % wariancji objawów depresji u dzieci (T3) oraz 32,1 % objawów depresji u rodziców (T3). Zależności między zmiennymi niezależnymi (T1), mediatorami (T2) i zmiennymi zależnymi (T3), a także główne wyniki przedstawiono na Rycinie 8. W celu wyeliminowania potencjalnie zakłócających efektów aktywności fizycznej w modelu uwzględniono zależności między umiarkowaną do intensywnej aktywnością fizyczną (MVPA) rodziców i dzieci (T1) a odpowiednimi zmiennymi niezależnymi i mediacyjnymi.

Analiza modelu wykazała jeden istotny efekt pośredni (b = 0,023, SE = 0,013, 95 % CI [0,003, 0,057], p = 0,022.) Wyższy poziom objawów depresji u dzieci (T1) był związany z dłuższym czasem ZS u dzieci (T2), co z kolei wyjaśniało wyższy poziom objawów depresji u rodziców (T3).

Analiza wrażliwości, uwzględniająca płeć, wiek, wykształcenie rodziców, postrzegany status ekonomiczny oraz efekty przypisania do grupy eksperymentalnej, potwierdziła, że efekty bezpośrednie i pośredni były zgodne z wynikami uzyskanymi w modelu podstawowym.

Dyskusja wyników Badania 4

Badanie 4 dostarcza nowych dowodów na istnienie podłużnych związków między objawami depresji a czasem spędzonym na zachowaniach siedzących w diadach rodzic-dziecko w wieku 9–15 lat, zarówno na poziomie wewnątrzosobowym, jak i międzyjednostkowym. Najbardziej spójny wzorzec zaobserwowano w przypadku zależności wewnątrzosobowych u dzieci, gdzie tworzy się „błędne koło": dłuższy czas ZS (T1) wyjaśniał wyższy poziom objawów depresji (po 8 miesiącach), a wyższy poziom objawów depresji (T1) wyjaśniał dłuższy czas ZS po 8 miesiącach (T2).

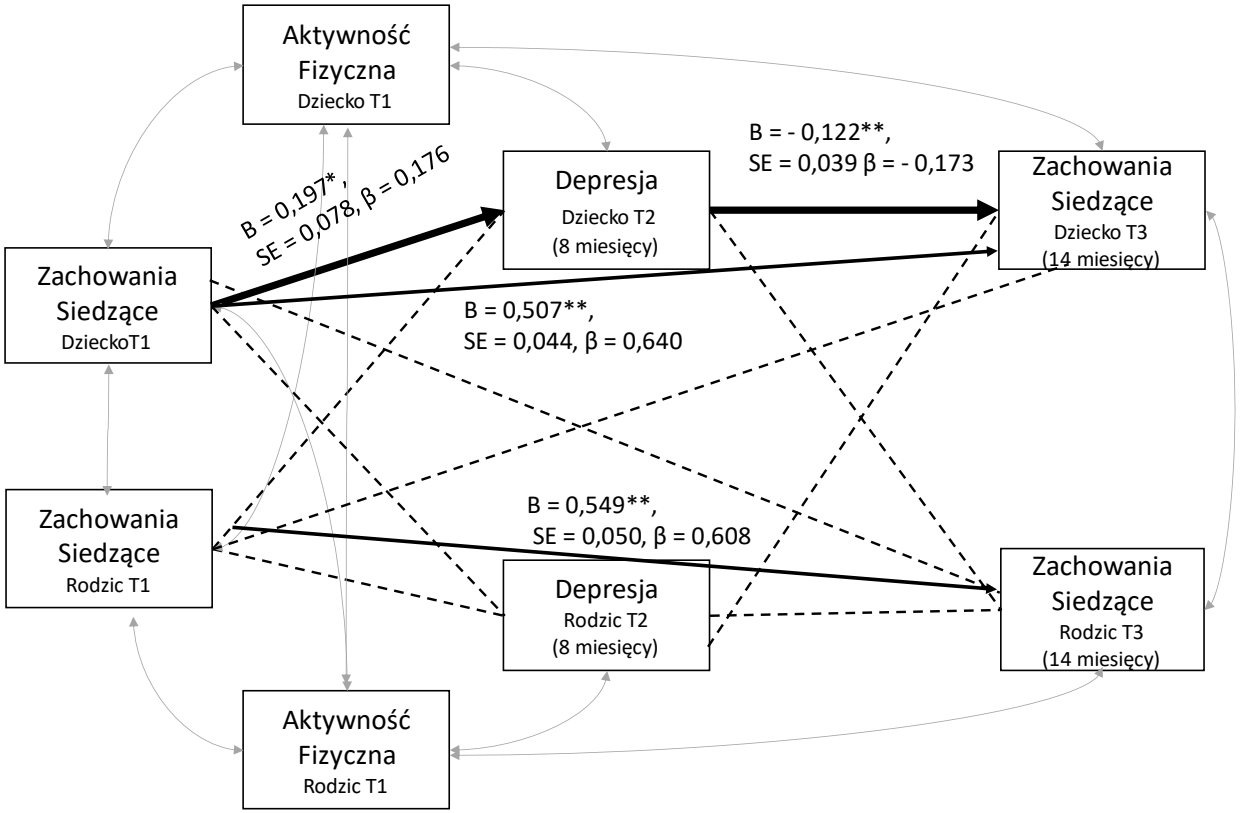
Po edukacji dotyczącej konsekwencji ZS dzieci z mniejszą liczbą objawów depresji (T2) mogły uznać, że nie potrzebują aktywnie ograniczać czasu ZS, co w rezultacie skutkowało dłuższym czasem siedzenia w T3. Jednocześnie rodzice mogli odczuwać

mniejszą presję, by modelować redukcję siedzenia po zakończeniu edukacji na temat ZS, co pozwalało im spędzać więcej czasu na relaksie w pozycji siedzącej lub półleżącej (T2), co z kolei mogło przyczyniać się do obniżenia poziomu objawów depresji u rodziców w T3.

Dzieci z wyższym poziomem objawów depresji na początku badania (T1) mogły mieć trudności z redukcją ZS, co prowadziło do zwiększania czasu ZS podczas kolejnego pomiaru (T2). Rodzice, zauważając brak zmian w zachowaniach dzieci po interwencji, mogli interpretować ten wzorzec jako porażkę swoich działań wychowawczych, co z kolei mogło wiązać się z wyższym poziomem objawów depresji u rodziców (T3). Dodatkowo, zachowania ocenione po 8 miesiącach (czyli po edukacji zwiększającej świadomość ZS i jego konsekwencji zdrowotnych), takie jak dłuższy czas ZS u rodziców, były związane z mniejszym poziomem objawów depresji u rodziców w T3 (po 14 miesiącach). Niższy poziom ZS u dziecka może być postrzegany przez rodziców jako potwierdzenie skuteczności ich podejścia wychowawczego (lub efektywności interwencji), co prowadziło do redukcji stresu rodzicielskiego. Dzięki temu rodzice mogli ograniczyć wysiłki w dalszym modelowaniu ograniczania ZS i pozwolić sobie na więcej czasu na odpoczynek w pozycji siedzącej lub półleżącej. To z kolei mogło przekładać się na lepsze samopoczucie rodziców, objawiające się niższym poziomem objawów depresji. Badanie to ukazuje złożoną dynamikę zależności między zachowaniami siedzącymi a zdrowiem psychicznym w relacjach rodzic–dziecko oraz wskazuje na możliwe różnice w mechanizmach regulujących te relacje w obu grupach.

Rycina 7.

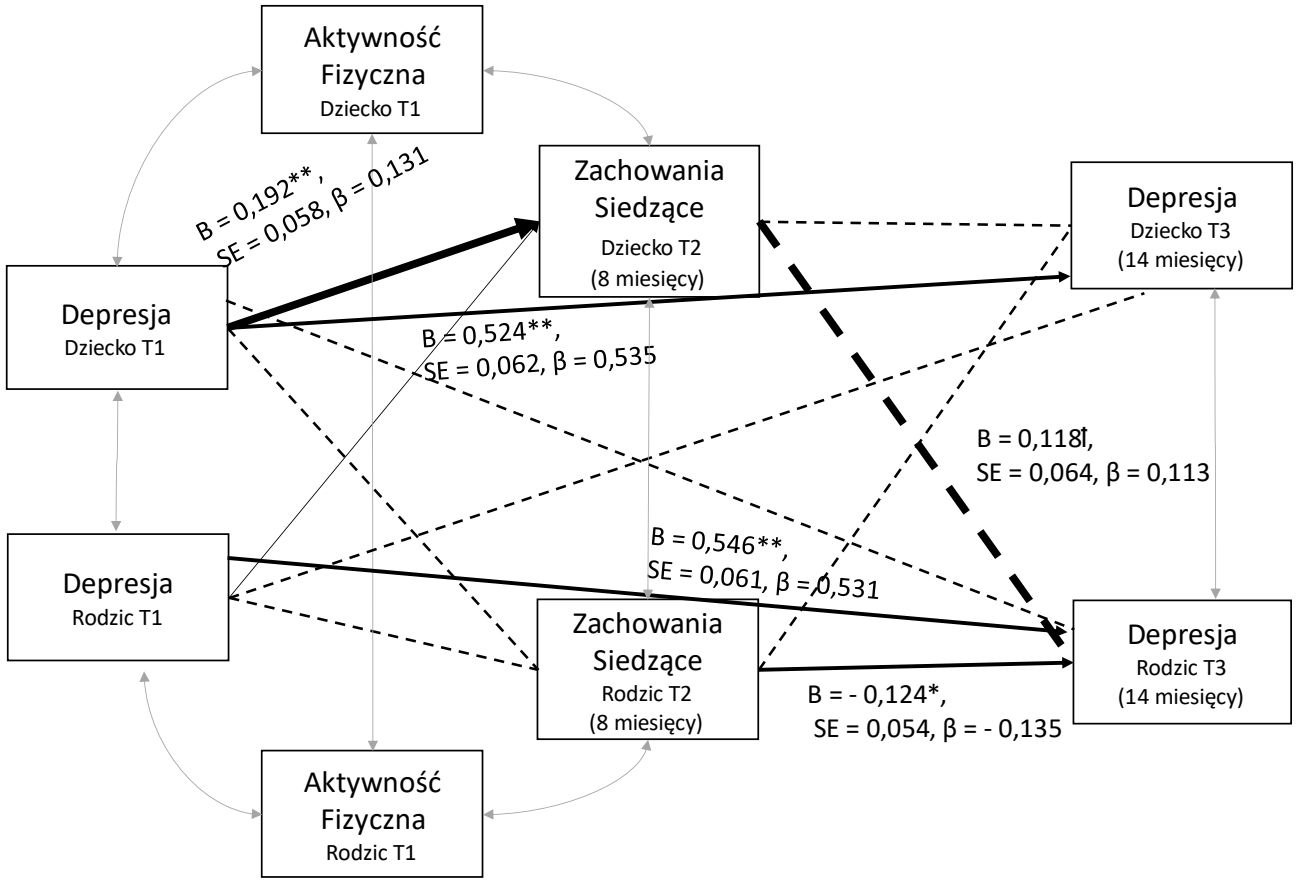
Bezpośrednie i pośrednie efekty dla modelu „Zachowania Siedzące → Objawy Depresji → Zachowania Siedząc



Nota. ** $p < 0{,}01$; * $p < 0{,}05$.Istotne efekty zaznaczono liniami ciągłymi. Istotne efekty pośrednie oznaczono pogrubionymi liniami. Czarne linie oznaczają efekty bezpośrednie, a szare linie oznaczają kowariancje. Przerywane linie reprezentują efekty bezpośrednie, które nie były istotne. Założono kowariancję reszt wskaźników symptomów depresji w T2 oraz wskaźników zachowań siedzących w T3. Depresja = objawy depresji; Aktywność fizyczna = minuty umiarkowanej do intensywnej aktywności fizycznej; T1 = Czas 1, punkt wyjściowy; T2 = Czas 2, 8 miesięcy po T1; T3 = Czas 3, 14 miesięcy po T1.

Rycina 8.

Bezpośrednie i pośrednie efekty dla modelu „Objawy Depresji → Zachowania Siedzące → Objawy Depresji”



Nota. ** p < 0,01; * p < 0,05.Istotne efekty zaznaczono liniami ciągłymi. Istotne efekty pośrednie oznaczono pogrubionymi liniami. Czarne linie oznaczają efekty bezpośrednie, a szare linie oznaczają kowariancje. Przerywane linie reprezentują efekty bezpośrednie, które nie były istotne. Założono kowariancję reszt wskaźników zachowań siedzących w T2 oraz symptomów depresji w T3. Depresja = objawy depresji; Aktywność fizyczna = minuty umiarkowanej do intensywnej aktywności fizycznej; T1 = Czas 1, punkt wyjściowy; T2 = Czas 2, 8 miesięcy po T1; T3 = Czas 3, 14 miesięcy po T1.

Konkluzje dla Badań 1–4

Podsumowując wyniki wszystkich czterech badań, możemy dostrzec złożone i wieloaspektowe zależności między kontrolą społeczną, satysfakcją z relacji, zachowaniami siedzącymi (ZS) oraz objawami depresji w kontekście diadycznym, takim jak relacje partnerskie i rodzicielskie. Wyniki wskazują, że kontrola społeczna – zarówno negatywna, jak i pozytywna – jest istotnym predyktorem czasu spędzanego na ZS. Te zależności należy jednak interpretować biorąc pod uwagę także poziom satysfakcji z relacji. W pierwszym badaniu umiarkowany poziom zadowolenia raportowany przez partnerów wyjaśniał stosowanie negatywnej kontroli społecznej, co z kolei było powiązane ze skróceniem czasu ZS u osoby docelowej, choć pełna hipoteza zakładająca związki pomiędzy kontrolą społeczną a satysfakcją z relacji i czasem ZS nie znalazła potwierdzenia. W relacjach rodzic-dziecko, jak pokazało drugie badanie, pozytywna kontrola stosowana przez rodziców korelowała z wyższym poziomem ZS zarówno u rodziców, jak i u dzieci. Jednocześnie satysfakcja z relacji spostrzegana przez rodzica była predyktorem wyższego czasu ZS, podczas gdy satysfakcja dziecka wyjaśniała niższy poziom ZS u rodzica.

Wyniki dotyczące zależności między objawami depresji a ZS wnoszą istotny wkład w rozumienie tzw. „błędnego koła” tych dwóch czynników. Trzecie badanie wykazało, że wyższy poziom objawów depresji u jednej osoby w diadzie prognozował dłuższy czas ZS u jej partnera, co wskazuje na wzajemne oddziaływanie w relacjach między tymi zmiennymi. Efekt ten zaobserwowano w parach, w których osoby docelowe doświadczały większego obciążenia emocjonalnego wynikającego z nadwagi, chorób przewlekłych lub innych czynników ryzyka. Podobne mechanizmy zaobserwowano w relacjach rodzic-dziecko, gdzie dłuższy czas ZS u dzieci wiązał się z większą liczbą objawów depresji, i odwrotnie. Wyniki sugerują, że osoby z objawami depresji mogą mieć trudności z inicjowaniem zmian w swoich

zachowaniach siedzących, co wzmacnia negatywny cykl między brakiem aktywności a stanem psychicznym.

Wyniki te sugeruja ważne implikacje praktyczne. Wskazują na konieczność uwzględnienia czynników emocjonalnych i psychospołecznych w interwencjach ukierunkowanych na zmniejszenie czasu ZS. Jednocześnie kluczowe jest branie pod uwagę kontekstu diadycznego, ponieważ dynamika relacji może kształtować zarówno skuteczność strategii, jak i długoterminowe wyniki zdrowotne. Dostosowanie interwencji do specyfiki relacji, poziomu satysfakcji oraz percepcji kontroli społecznej może zwiększyć ich efektywność. Warto również, aby kontrola społeczna była stosowana w sposób wspierający i mobilizujący, a nie dominujący, ponieważ sposób jej odbioru przez drugą osobę odgrywa kluczową rolę w motywowaniu do zmiany. Zintegrowana strategia uwzględniająca te czynniki może nie tylko pomóc w ograniczeniu czasu ZS, ale również zmniejszyć objawy depresji, przyczyniając się do poprawy ogólnego dobrostanu uczestników.

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Spis publikacji naukowych stanowiących spójny tematycznie zbiór artykułów

Publikacja dotycząca Badania 1

Siwa, M., Szczuka, Z., Banik, A., Kulis, E., Boberska, M., Wietrzykowska, D., Knoll, N., DeLongis, A., Knäuper, B., & Luszczynska, A. (2023a). The dyadic interplay between relationship satisfaction, perceived positive and negative social control, and a reduction of sedentary behavior time. *Annals of Behavioral Medicine*, *57*(2), 165–174. https://doi.org/10.1093/abm/kaac032

Publikacja dotycząca Badania 2

Siwa, M., Kulis, E., Banik, A., Szczuka, Z., Boberska, M., Wietrzykowska, D., Knoll, N., DeLongis, A., Knäuper, B., & Luszczynska, A. (w recenzjach). Positive and negative parental social control, relationship satisfaction, and sedentary behavior in parent-child dyads. *Annals of Behavioral Medicine*

Publikacja dotycząca Badania 3

Siwa, M., Kulis, E., Banik, A., Szczuka, Z., Boberska, M., Wietrzykowska, D., Knoll, N., DeLongis, A., Knäuper, B., & Luszczynska, A. (2023b). Associations between depressive symptoms and sedentary behaviors in dyads: Longitudinal crossover effects. *Mental Health and Physical Activity*, *24*, 100501. https://doi.org/10.1016/j.mhpa.2022.100501

Publikacja dotycząca Badania 4

Siwa, M., Wietrzykowska, D., Szczuka, Z., Kulis, E., Boberska, M., Banik, A., Zaleskiewicz, H., Krzywicka, P., Knoll, N., DeLongis, A., Knäuper, B., & Luszczynska, A. (w recenzjach). Associations Between Depressive Symptoms and Sedentary Behaviors in Parent-Child Dyads: Longitudinal Effects Within- and Across Individuals**.** *Mental Health and Physical Activity*

Oświadczenia współautorów publikacji dotyczącej Badania 1

The Co-Authorship Statement

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Publication: Siwa, M., Szczuka, Z., Banik, A., Kulis, E., Boberska, M., Wietrzykowska, D., Knoll, N., DeLongis, A., Knäuper, B., & Luszczynska, A. (2023). The Dyadic Interplay Between Relationship Satisfaction, Perceived Positive and Negative Social Control, and a Reduction of Sedentary Behavior Time. *Annals of Behavioral Medicine*, *57*(2), 165–174. https://doi.org/10.1093/abm/kaac032

We, the undersigned, co-authors of the above publication, confirm that the above publication has not been submitted as evidence for which a degree or other qualification has already been awarded.

We, the undersigned, further indicate the candidate's contribution to the publication in our joint statement below.

Statement indicating the candidate's contribution to the publication: The candidate contributed to the conception of the study, participated in its design and data collection, led the interpretation of the data, led data analysis, and drafted the manuscript.

The contribution of co-authors: The co-authors contributed to the conception of the study, participated in data collection, contributed to interpretation of the data, and contributed to drafting and revising the manuscript.

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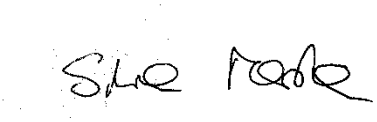

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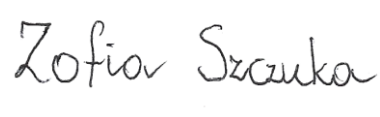

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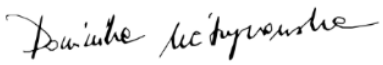

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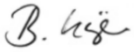

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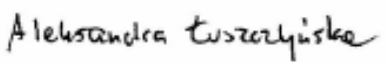

Oświadczenia współautorów publikacji dotyczącej Badania 2

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Name of the candidate: Maria Siwa

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We, the undersigned, co-authors of the above publication, confirm that the above publication has not been submitted as evidence for which a degree or other qualification has already been awarded.

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The contribution of co-authors: The co-authors contributed to the conception of the study, participated in data collection, contributed to interpretation of the data, and contributed to drafting and revising the manuscript.

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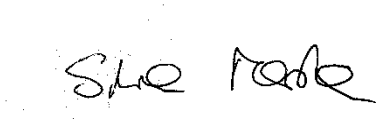

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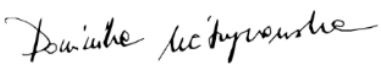

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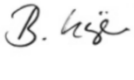

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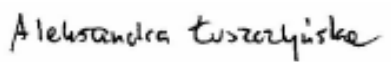

Oświadczenia współautorów publikacji dotyczącej Badania 3

The Co-Authorship Statement

Name of the candidate: Maria Siwa

Publication: Siwa, M., Kulis, E., Banik, A., Szczuka, Z., Boberska, M., Wietrzykowska, D., Knoll, N., DeLongis, A., Knäuper, B., & Luszczynska, A. (2023). Associations between depressive symptoms and sedentary behaviors in dyads: Longitudinal crossover effects. *Mental Health and Physical Activity*, *24*, 100501. https://doi.org/10.1016/j.mhpa.2022.100501

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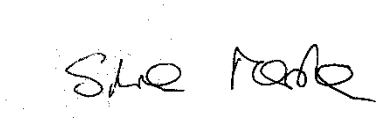

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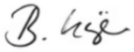

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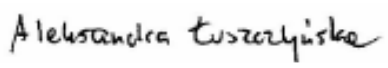

Oświadczenia współautorów publikacji dotyczącej Badania 4

The Co-Authorship Statement

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Publication: Siwa, M., Wietrzykowska, D., Szczuka, Z., Kulis, E., Boberska, M., Banik, A., Zaleskiewicz, H., Krzywicka, P., Knoll, N., DeLongis, A., Knäuper, B., & Luszczynska, A. (submitted). Associations Between Depressive Symptoms and Sedentary Behaviors in Parent-Child Dyads: Longitudinal Effects Within- and Across Individuals. *Mental Health and Physical Activity*

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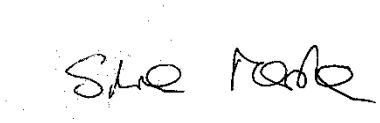

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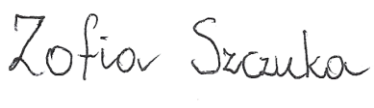

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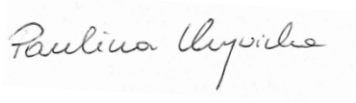

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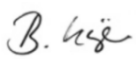

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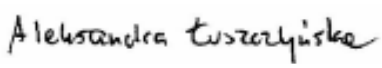

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The Dyadic Interplay Between Relationship Satisfaction, Perceived Positive and Negative Social Control, and a Reduction of Sedentary Behavior Time

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Abstract

Background Both the close relationship processes and health model and the dyadic health influence model posit that beliefs about the relationship (e.g., relationship satisfaction) and influence strategies (e.g., social control) serve as mediators of health behavior change. The evidence for such mediation is limited.

Purpose This study investigated two competing hypotheses that arise from these models: (1) perceived use of positive and negative social control (attempts to influence the partner's behaviors) predict sedentary behavior (SB) indirectly, via relationship satisfaction; or (2) relationship satisfaction predicts SB indirectly, via positive and negative social control.

Methods Data from 320 dyads (target persons and their partners, aged 18–90 years), were analyzed using mediation models. SB time was measured with GT3X-BT accelerometers at Time 1 (T1; baseline) and Time 3 (T3; 8 months following baseline). Relationship satisfaction and social control were assessed at T1 and Time 2 (T2; 2 months following baseline).

Results Higher T1 relationship satisfaction among target persons predicted target persons' reporting of higher T2 negative control from partners, which in turn predicted lower T3 SB time among target persons. Lower T1 relationship satisfaction among partners predicted target persons' reporting of higher T2 perceived negative control from partners, which predicted lower T3 SB time among target persons. On average, both members of the dyad reported moderate-to-high relationship satisfaction and low-to-moderate negative control.

Conclusions In contrast to very low levels of negative control, its low-to-moderate levels may be related to beneficial behavioral effects (lower SB time) among target persons reporting moderate-to-high relationship satisfaction.

Keywords Social control · Relationship satisfaction · Sedentary behavior · Dyads · Accelerometer

Sedentary behavior (SB) is defined as any waking activity characterized by an energy expenditure ≤ 1.5 METs while in a sitting, lying, or reclining posture [1]. This behavior is becoming prevalent across domains of human activity due to changes in workplace, the use of entertainment technologies, transportation, and communications [2]. Longer time spent in SB is associated with an increased risk of metabolic syndrome, type-2 diabetes, cardiovascular diseases, and lower physical quality of life [3, 4]. SB may be responsible for approximately 0.5 million deaths/year, representing 3.8% of all-cause mortality [4]. The World Health Organization (WHO) [5] recommends that adults limit time spent in SB and replace it with physical activity (PA) to help reduce detrimental effects of SB on health.

Social process variables are listed among key potential determinants of energy expenditure behaviors, including SB [6]. Social control is one type of social process variable that has the potential to influence SB, as hypothesized in the landmark publication by Lewis and Rook [7]. Social control is defined as any attempt by one partner to influence the other partner's health or health behaviors [7, 8]. Positive social control refers to agents' use of persuasion, rational logic, and positive reinforcement, while negative social control refers to expressions of negative emotions, or attempts to induce negative emotions in the target person to influence their behavior [9, 10]. Unlike social support, interactions involving social control need not be affirming or provide resources [9]. While positive and negative social control attempts are intended to

elicit positive behavioral changes, improvements in health behavior may be accompanied by increases in distress, evoked by the ways control is delivered [7].

To date, dyadic studies investigating the associations between social control and health behaviors have reported mixed findings [9–11]. A meta-analysis found moderate beneficial effects of positive social control on health-promoting behaviors, but high levels of negative social control were associated with lower engagement in health-promoting behaviors (small effect sizes were observed) [8]. The findings were of high heterogeneity, focusing on within-individual associations, obtained mostly in cross-sectional studies, and SB was not investigated [8]. We identified only one dyadic study explaining links between social control and SB. Parental and child perceptions of the use of control-based strategies by parents were unrelated to self-reported child SB, assessed at an 8-month follow-up [12].

Relationship satisfaction is yet another relationship factor predicting health behaviors among people who are recommended to change their lifestyle and to become more active [13]. The associations between relationship satisfaction, social control, and health behaviors are explained by a framework for investigating dyadic relationship processes and health [14]. This framework [14] indicates that variables such as social support or control may predict relationship mediators (including relationship satisfaction), which in turn predict physiological states, affect, and health behavior. Importantly, the framework assumes that these variables may also be chained in a different order: relationship factors (including relationship satisfaction) may predict social process variables (provision and receipt of social support and control), which in turn explain health-related outcomes. In other words, relationship satisfaction, and social control may operate either as the predictors or as the mediators when explaining health behaviors [14]. The mediating role of social control is also in line with Hoffman et al.'s [15] framework, linking fluctuations in relationship satisfaction with mediator variables, including facilitators of effective self-regulation (e.g., social exchange processes), which in turn determine the achievement of behavioral goals.

The evidence-based dyadic health influence model (DHIM) [16] suggests complex indirect pathways through which beliefs about the relationship (such as relationship satisfaction) and social influence strategies (such as social control) may explain health behaviors of the target person. As proposed in the DHIM [16], the use of influence strategies (e.g., social control) by the partner may predict the target person's relational beliefs (e.g., relationship satisfaction), which in turn are related to the target person's health behaviors. For example, the partner's use of social influence strategies may trigger relationship-relevant thoughts, such as the target person's commitment to the relationship or beliefs about the importance of the relationship. Perceptions of high (or improved) relationship satisfaction and importance may prompt the target person to engage in a healthier behavior (e.g., reduce their SB time) because of the desire to obtain the affection of their partner and to maintain satisfactory relationship [16]. The review by Huelsnitz et al. [16] suggests that these hypothesized indirect associations have not been tested. Furthermore, the DHIM [16] proposes that the partner's relational beliefs (e.g., anxiety about relationship, feeling dissatisfied) may prompt them to use influence strategies (including social control, such as guilt induction), which in turn may affect the target person's health behavior. As indicated by Huelsnitz et al. [16] such indirect effects hypotheses have not been tested.

In line with the DHIM [16] a moderate, although not high, level of relationship satisfaction may prompt partners to use some social control strategies (positive or negative) in order to evoke a change in the target person's behavior. In turn, the target person who is highly satisfied with the relationship may be sensitive to even small cues and likely to wait for their partner's signaling a need for change (and thus perceive social control). Perceived social control may trigger target person's willingness to act in line with the perceived influence strategy (e.g., negative social control), and engage in a healthy behavior to further satisfy the partner, and maintain the satisfactory relationship.

The majority of research on links between relationship satisfaction and health behaviors has been conducted in the context of romantic relationships [13, 17]. Behaviors such as SB occur across various settings and contexts, and may be undertaken without a romantic partner (e.g., at work, during leisure time [2]). Thus, research investigating people who intend to change their SB may also include types of dyads other than romantic, namely any types of dyads in which two individuals intend to reduce SB, or at least one person intends to become more active and the other person intends to support the target person during the behavior change process [18]. In any case, the type of the relationship should be controlled in dyadic research. Additionally, as indicated in health behavior change frameworks (e.g., implementation intentions) and dyadic research [18–21], intention is one of the key proximal determinants of health behavior, thus the strength of intention should be controlled in behavior change research.

In line with the DHIM and the framework for investigating dyadic relationship factors and health [14, 16], two competing mediation models were tested. First, we examined whether the target persons' and partners' perceived positive, and negative social control from the other person in the dyad (Time 1; T1) would predict their SB (measured at Time 3, T3; 8 months after T1) indirectly, with target persons', and partners' relationship satisfaction (Time 2, T2; 2 months after T1) mediating these associations. Second, we examined whether relationship satisfaction (T1; target persons and their partners) would predict SB (T3; target persons and partners) indirectly, with target persons' and partners' perceived positive, and negative social control from the other person in the dyad (T2) mediating these associations.

Method

Participants

At Time 1, participants were 640 adults forming N = 320 dyads (320 target persons and 320 partners). Time 3 measurement (8 months after T1) was completed by n = 288 target persons and n = 292 partners, indicating that the total longitudinal dropout was only 6.45%.

The baseline sample of target persons (64.4 % women) were 18–90 years old (M = 43.86, SD = 17.02). Their partners (64.1% women) were 18–84 years old (M = 42.32 years; SD = 16.55). The majority of target persons (61.6%) and partners (51.0%) were overweight or obese; 36.6% target persons and 47.1% partners had normal body weight. Regarding chronic diseases, 66.6% of target persons and 40.6% partners reported a diagnosis of type-2 diabetes or cardiovascular diseases (with or without comorbidities) or

other chronic diseases (e.g., musculoskeletal disorders). Furthermore, 87.8% target persons declared that they did not meet PA recommendations [5, 22], and the remaining 12.12% reported that they received physician's recommendations to improve their PA levels due to cardiovascular diseases/ type-2 diabetes. Among partners, 77.5% reported that they did not meet PA recommendations. Target persons and their partners reported that they intended to reduce their own SB levels at T1 (M_{TP} = 2.91, SD = 0.65; M_{p} = 2.89, SD = 0.65). Intentions of both persons in the dyads were similar in strength, paired $t(1, 319) = 0.46$, $p = .694$. The majority of dyads were in a romantic relationship (61.6%), whereas 38.4% of dyads were in other relationships, involving at least several face-to-face meetings every week (e.g., close friends, family members, workmates). All dyads were in a relationship for > 6 months.

About half of the participants (57.50% target persons and 56.80% partners) had completed higher education; 40.30 % of target persons and 41.90% of partners had a high school or a vocational diploma, or some post-secondary (non-tertiary) education; 2.20% of target persons and 1.30% of partners reported primary education. Half of the target persons (52.20%) and partners (49.40%) perceived their economic status as similar to the economic status of the average family in Poland, 42.20% target persons and 43.70% partners indicated that their economic status was above average; 5.60% target persons and 6.90% partners described their economic situation as worse than the economic status of the average family.

Procedures

This study reports secondary findings of a randomized controlled trial (pre-registered at ClinicalTrials.gov, #NCT03011385). The trial investigated the effects of PA planning interventions (7 planning/control procedures sessions delivered, between 1 week after T1, and 1 week after T2), combined with a healthy lifestyle education (addressing SB, PA, and healthy diet). The primary outcomes were PA and SB assessed over 8 months. To date, the published reports from this trial present the effects of the intervention on PA and SB, whereas social control, and relationship satisfaction were not analyzed [19, 20]. The findings indicated no effects of a planning intervention on SB time at T3 (8 months after T1), neither among target persons nor partners [20]. There was, however, a small effect of a collaborative planning intervention on a reduction of SB time at short-term (1 week after T1) among target persons. This short-term SB assessment was not accounted for in the present study.

Besides the planning interventions or the control condition procedures, all target persons and their partners took part in identical education sessions addressing SB. The education addressed SB definitions and patterns, SB health consequences, and ways to break SB bouts, and reduce overall SB time. No behavior change techniques addressing relationship satisfaction or social control were applied.

T1 self-report was followed by 6 days of accelerometer-based SB measurement, and by T2 self-report assessment, taking place at 2 months after T1. T3 was conducted at 8 months after T1 and included self-reports, followed by 6 days of accelerometer-based SB measurement. Data were collected individually (dyads completed questionnaires separately) during face-to-face meetings of one dyad with an experimenter.

The inclusion criteria were: (1) target persons and partners were ≥ 18 years old; (2) the dyad included a distinguishable target person (i.e., the individual who did not meet the recommended thresholds of PA [22] and/or was recommended by a specialist to reduce SB and increase their PA levels due to a chronic illness such as type-2 diabetes, cardiovascular diseases) and their partner; (3) target persons reported at least moderate intentions to initiate regular PA (4); the dyad was in a close relationship, defined as a romantic or other close relationship (family members, close friends, coworkers) involving several meetings each week; and (5) the relationship lasted > 6 months. Both target person and their partner could report strong intentions to reduce their SB levels or increase PA.

Data were collected between December 2016 and February 2020 in 24 urban locations and 7 rural locations in Poland. Participants were recruited via advertisements published in social media or on websites of non-governmental organizations; recruitment was also conducted during municipality-held health promotion events. Potential participants were informed about the study aims and procedures. After familiarizing themselves with the study goals, participants were screened for eligibility, and were asked to provide informed consent. Overall, 461 dyads were screened for eligibility; 141 either did not meet the inclusion criteria or decided not to take part in the study.

The study was approved by the Ethics Committee at the first author's institution. All participants provided informed consent. There was no payment for participation; participants received a thank-you gift (value 5–10 EUR) after each measurement.

Measures

Means, standard deviations, and internal consistency coefficients are presented in Electronic Supplementary Material 1, Table S1.

Sedentary Behavior Time (T1 and T3)

SB time data were obtained with ActiGraph GT3X-BT accelerometers. Participants were instructed on how to use the devices and asked to report daily hours of wearing time during their waking hours for 6 days. Data obtained from each participant were used in the analyses only if devices had been worn for at least 8 hr per day, for a minimum of 3 days during the corresponding time period [23]. Data scoring methods were based on the Freedson VM3 [24] and the Freedson Adult [25] algorithms with the Actilife software [24]. Non-wear time was calculated using epoch-based algorithm based on Choi [26]; 10-sec epochs were used for a better distinction between SB and PA [27]. SB time was calculated as the average minutes of SB per every hour of device wearing time.

Perceived Positive and Negative Social Control (T1 and T2)

Seven items were used to assess if target persons and their partners perceived that the other person in the dyad used positive or negative social control to encourage SB reduction. Positive social control was assessed with 4 items based on Lewis and Butterfield [28] and Thorpe [29]: "How does your partner influence (motivate) you to limit the time you spend sitting? (1) repeatedly reminds you to take active breaks; (2) makes suggestions or drops hints; (3) uses humor; (4) uses praises and compliments." Negative social control was assessed with 3 items based on Lewis and Butterfield [28] and Thorpe [29]: "How does your partner influence (motivate) you to limit

the time you spend sitting? (5) being persistent; (6) trying to make you feel guilty; and (7) saying that you would change if you cared for him/her." The responses, were provided on a 4-point scale ranging from 1 (totally disagree) to 4 (totally agree). Cronbach's α coefficients ranged between.89 and.92 (see Electronic Supplementary Material 1, Table S1).

Relationship Satisfaction (T1 and T2)

To measure relationship satisfaction, a four-item version of the Couple Satisfaction Index (CSI-4) [30] was used. Participants were instructed to evaluate their relationship with the other person in the dyad using the following items: "Please indicate the degree of happiness, all things considered, of your relationship", with answers ranging from 1 (very unhappy) to 4 (very happy);" "I have a warm and comfortable relationship with my partner," with answers ranging from 1 (totally agree) to 4 (totally disagree); "How rewarding is your relationship with your partner?," with answers ranging from 1 (not at all) to 4 (completely); "In general, how satisfied are you with your relationship?," with answers ranging from 1 (not at all) to 4 (completely). Although CSI-4 [30] was developed in the context of the romantic relationship, our pilot study (n = 11) indicated that CSI-4 items were perceived as adequately describing satisfaction with the relationship in non-romantic dyads. Values of Cronbach's α coefficient ranged between .87 and .93 for the total sample (see Electronic Supplementary Material 1, Table S1), between .84 and .94 in participants from dyads in a romantic relationship, and between .88, and .93 in participants from non-romantic dyads.

Control Variables

Sociodemographic covariates used in the sensitivity analysis were: (1) age; (2) gender; (3) education (elementary, vocational, high school, post-secondary, bachelor, master, other—please specify); (4) self-reported economic status, with responses varying from 1 (much above the average family in Poland) to 5 (much below the average family in Poland); (5) the type of relationship (romantic relationship = 1, vs. other, i.e., close family relationship, close friendship, work-related relationship = 0). T1 intention to reduce SB was assessed with 2 items [31], e.g., "I intend to sit for a maximum of 5 hr (in total) a day over the next week." Responses ranged from 1 (definitely not) to 4 (definitely yes) (target persons: r =.23, p < .001, M = 2.91, SD = 0.65; partners: r =.10, p = .070, M = 2.89, SD = 0.65).

Data Analysis

The G*Power calculator (simulating a multiple regression model) was used to conduct a priori calculations of the sample size. Assuming small effect sizes f^2 = .05 (in line with previous dyadic longitudinal research [32, 33]), power of .80, Type I error rate of .05 and accounting for age and gender, the determined sample size was approximately 300 dyads.

Path analyses were performed using IBM AMOS versions 26, using maximum likelihood estimation. The two hypothesized models assumed that target persons and partners were distinguishable, and accounted for three measurement points, with the independent, mediator, and dependent variables assessed at separate time points, controlling for T1-level of the dependent variable. Several model-data fit indices were applied. A cutoff point of ≤ .08 for the root mean square error of approximation (RMSEA) was used [34]. A cutoff point ≥ .95 indicating good model-data fit, was applied for the comparative fit index (CFI) and the normed fit index (NFI) [34]. The indirect effects were evaluated with unstandardized effect coefficients, calculated with 10,000 bootstraps (95% CI). Missing data (including data missing due to drop-outs at T2 and T3) were accounted for by using the full information maximum likelihood procedure [34]. Little's MCAR test indicated that the missing data patterns were systematic, Little's $\chi^2(N = 766) = 849.535$, p = .019. Mardia's coefficient of multivariate normality (values of 11.22 and 8.52) indicated moderate non-normality.

Analytic Strategy for the Mediation Models

All models assumed that persons within dyads were distinguishable, with set roles as target persons, and partners. Although models were estimated in line with recommendations for actor-partner interdependence model with mediators (APIMeMs) [35], we refrain from using the terms "actor" and "partner" in describing the effects. The models were saturated in terms of the associations between the independent, mediator, and dependent variables, and their respective covariances (e.g., the residuals of independent variables, mediators, and outcome variables were assumed to covary) [35]. The SB indicators at T1, assessed in target persons and partners, were assumed to covary and predict T3 indicators of SB measured in both dyad members. Instead of using one model to test all mediation hypotheses, two hypothesized mediation models were calculated. This strategy allowed us to reduce the potential bias related to multi-collinearity and prevented a reduction of power of analysis related to a high number of parameters in the model (for a similar strategy see [33]).

Several indirect effects were tested: (1) those with the independent, mediator, and dependent variables measured in one person; (2) those with at least one variable in the chain of "the independent variable → the mediator → the dependent variable" measured in one person, and at least one variable in this chain measured in the other person. The total effects, total indirect effects, simple indirect effects, and direct effects were calculated, using the user-defined estimands function [35, 36]. To account for the dyadic interdependence, the independent variables' indicators (T1) were assumed to correlate; SB indicators (T1) measured in the target persons, and partners were also assumed to correlate. Residuals of the mediators (T2) and SB (T3), measured in both persons in a dyad, were assumed to covary.

Sensitivity analyses were conducted in order to assess the robustness of the findings [37]. We examined whether the pattern of associations was similar in the hypothesized model and the model controlling for the type of relationship (romantic vs. other), target persons and partners' age, gender, education, economic status (T1), and finally, the effects of the experimental group assignment (1 = PA planning intervention, 0 = the control group) on the mediator and dependent variables. Additionally, a two-group model assuming that direct and indirect effects are equal across two types of dyads (romantic vs. other relationship types) was compared with an unconstrained model [34]. The comparison allowed us to test if the observed direct and indirect effects were similar regardless of the type of the relationship. In case fit indices are good for the two compared models, the more parsimonious model (assuming equality of direct and indirect effects) should be accepted [34].

Results

Preliminary Analyses

Bivariate correlations among study variables, as well as means and standard deviations, are presented in Electronic Supplementary Material 1, Table S1.

Among target persons and partners, analyses for T1 data showed no differences between completers and drop-outs (see Electronic Supplementary Material 1).

There was no change in SB time from T1 to T3 among target persons, $F(1, 319) = 3.33$, $p = .069$, $\eta^2 = .010$ (the average SB time per hour time at T1: $M_{TP} = 36.05$, $SD = 5.48$; T3: $M_{TP} = 35.56$, $SD = 5.53$), or among partners, $F(1, 319) = 0.75$, $p = .388$, $\eta^2 = .002$.

On average, target persons and partners reported that they were satisfied with the relationship (T1 mean item response on a scale ranging from 1 to 4: $M_{TP} = 3.50$, $SD = 0.56$; $M_P = 3.46$, $SD = 0.56$). There were no significant differences in satisfaction between target persons and partners, either at T1, paired $t(1, 319) = 1.48$, $p = .141$, or at T2, paired $t(1, 319) = -0.56$, $p = .580$. Between T1 and T2 there was a small reduction in satisfaction among target persons, $F(1, 319) = 10.81$, $p = .001$, $\eta^2 = .033$, but partners reported stable relationship satisfaction across 2 months, $F(1, 319) = 1.17$, $p = .281$, $\eta^2 = .004$. At T1, in 90.3 % ($n = 289$) of dyads both target persons and partners indicated that they were satisfied or very satisfied with their relationship (mean item responses ≥ 2.6 on a scale ranging from 1 to 4).

Target persons reported higher T1 perceived negative control than did their partners, albeit mean levels were low-to-moderate across participants ($M_{TP} = 1.83$, $SD = 0.81$; $M_P = 1.65$, $SD = 0.73$), paired $t(1, 319) = 3.25$, $p = .001$. Target persons reported higher T1 positive control than did their partners ($M_{TP} = 2.28$, $SD = 0.84$; $M_P = 2.13$, $SD = 0.83$), paired $t(1, 319) = 2.80$, $p = .005$. At T2, both persons in the dyad perceived similar low levels of negative control ($p = .152$), but target persons perceived higher positive control than did their partners ($M_{TP} = 2.27$, $SD = 0.75$; $M_P = 2.17$, $SD = 0.75$), paired $t(1, 319) = 2.02$, $p = .044$.

Findings for the "Control →Relationship Satisfaction →SB Time" Model

The hypothesized model, calculated for $N = 320$ dyads, had an acceptable fit, with $\chi^2(14) = 25.39$, $p = .031$, $\chi^2/df = 1.814$, NFI = .975, CFI = .988, RMSEA = .051 (90% CI [.015, .081]). The variables in the model explained 41.9% of variance in target persons' SB (T3) and 51.5% of partners' SB (T3). Associations between the independent variables (T1), mediators (T2), and the dependent variables (T3) are presented in Figure 1 and Table 1. For the values of covariance coefficients see Electronic Supplementary Material 1 (Table S2).

There were no significant simple indirect effects (Electronic Supplementary Material 1, Table S3). However, the analyses conducted for the hypothesized model yielded three direct effects on SB (T3). A higher level of target persons' perceived positive control (T1) was related to *more time spent on SB* among target persons (T3), but also with *less time spent on SB* among their partners (T3). A higher level of target persons' perceived negative control (T1) was related to *less time spent on SB* among target persons (T3). Relationship satisfaction indices (T2) were unrelated to SB (T3) of target persons or partners. High levels of target persons' perceived positive control (T1) and low levels of target persons' perceived negative control (T1) were associated with high levels of their own and their partners' relationship satisfaction (T2). Partners' perceived positive control (T1) was likewise positively associated with partners' relationship satisfaction (T2).

The sensitivity analysis, accounting for gender, age, education, and economic status, (T1) of target persons and partners,

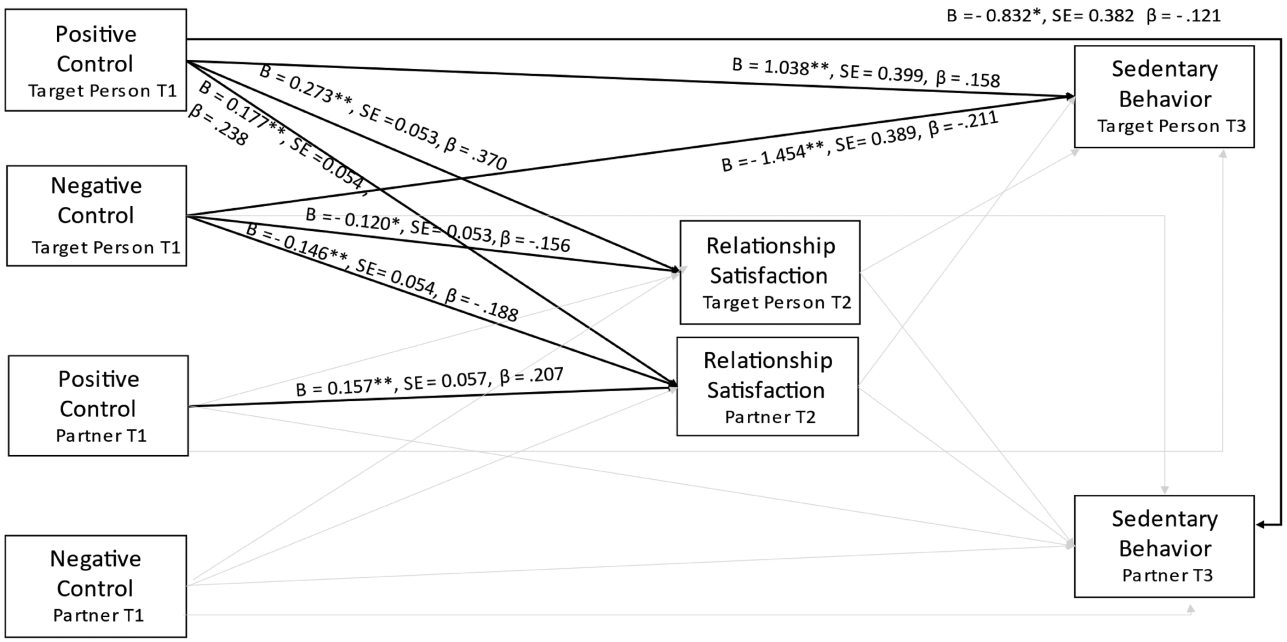

Fig. 1. Direct effects for the "Relationship Satisfaction → Control → SB Time" Mediation Model.**$p < .01$; *$p < .05$. Only significant effect coefficients are presented along solid black lines. Gray lines represent direct effects that were not significant. T1 = Time 1, the baseline; T2 = Time 2, 8 weeks after T1; T3 = Time 3, 8 months after T1. Residuals of all predictors, mediators, and the outcome variables were assumed to covary (for clarity, covariances are not displayed in Figure 1).

Table 1 Direct effects for the "Control → Relationship Satisfaction → Sedentary Behavior Time" Mediation Model.

Direct associations between variables in the model	*B*	*SE*	*β*	*p*
Positive Control (TP, T1) → Relationship Satisfaction (TP, T2)	**0.273**	**0.053**	**.370**	**<.001**
Positive Control (TP, T1) → Relationship Satisfaction (P, T2)	**0.177**	**0.054**	**.238**	**.001**
Positive Control (TP, T1) → Sedentary Behavior (TP, T3)	**1.038**	**0.399**	**.158**	**.009**
Positive Control (TP, T1) → Sedentary Behavior (P, T3)	**-0.832**	**0.382**	**-.121**	**.030**
Positive Control (P, T1) → Relationship Satisfaction (TP, T2)	0.088	0.056	.117	.112
Positive Control (P, T1) → Relationship Satisfaction (P, T2)	**0.157**	**0.057**	**.207**	**.006**
Positive Control (P, T1) → Sedentary Behavior (TP, T3)	-0.247	0.406	-.037	.542
Positive Control (P, T1) → Sedentary Behavior (P, T3)	-0.035	0.389	-.005	.928
Negative Control (TP, T1) → Relationship Satisfaction (TP, T2)	**-0.120**	**0.053**	**-.156**	**.024**
Negative Control (TP, T1) → Relationship Satisfaction (P, T2)	**-0.146**	**0.054**	**-.188**	**.007**
Negative Control (TP, T1) → Sedentary Behavior (TP, T3)	**-1.454**	**0.389**	**-.211**	**<.001**
Negative Control (TP, T1) → Sedentary Behavior (P, T3)	0.343	0.373	.048	.357
Negative Control (P, T1) → Relationship Satisfaction (TP, T2)	-0.047	0.061	-.054	.444
Negative Control (P, T1) → Relationship Satisfaction (P, T2)	-0.039	0.062	-.046	.526
Negative Control (P, T1) → Sedentary Behavior (TP, T3)	-0.170	0.439	-.022	.698
Negative Control (P, T1) → Sedentary Behavior (P, T3)	0.463	0.420	.058	.270
Sedentary Behavior (TP, T1) → Sedentary Behavior (TP, T3)	**0.630**	**0.043**	**.624**	**<.001**
Sedentary Behavior (P, T1) → Sedentary Behavior (P, T3)	**0.667**	**0.037**	**.707**	**<.001**
Relationship Satisfaction (TP, T2) → Sedentary Behavior (TP, T3)	-0.098	0.484	-.011	.839
Relationship Satisfaction (TP, T2) → Sedentary Behavior (P, T3)	0.213	0.463	.023	.645
Relationship Satisfaction (P, T2) → Sedentary Behavior (TP, T3)	0.026	0.474	.003	.956
Relationship Satisfaction (P, T2) → Sedentary Behavior (P, T3)	0.678	0.454	.073	.135

Values of direct and indirect effect estimates presented in bold are significant at $p < .05$. Each bootstrap was based on 10,000 repetitions. BCI = Bias-corrected confidence intervals. BCI that do not include zero indicate a significant indirect effect. T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; TP = Target Person; P= Partner.

the type of relationship (1 = romantic vs. 0 = other), and the effects of experimental group assignment on the mediator and dependent variables indicated patterns of effects similar to those obtained in the hypothesized model (Electronic Supplementary Material 1, Tables S4-S6). Thus, the robustness of the findings was confirmed.

The two-group model analysis, comparing dyads in romantic vs. non-romantic relationships, indicated that the model which assumed that all direct and indirect effects were equal across the two groups, had a good model-data fit (see Electronic Supplementary Material 1, Table S7). Thus, the more parsimonious model, assuming equality of the associations across two types of dyads, was accepted [34]. The two-group model yielded a similar pattern of associations to those found for the hypothesized one-group model (Electronic Supplementary Material 1, Table S8).

Findings for the "Relationship Satisfaction →Control →SB Time" Model

The hypothesized model, calculated for $N = 320$ dyads, had an acceptable fit, with $\chi^2(14) = 30.34$, $p = .007$, $\chi^2/df = 2.167$, NFI = .973, CFI = .985, RMSEA = .060 (90% CI [.031, .090]). The variables in the model explained 40.5% of variance of target persons' SB (T3) and 50.5% of partners' SB (T3). For associations between the independent variables (T1), mediators (T2), and the dependent variables (T3), see Figure 2 and Table 2. The values of covariance coefficients are presented in Electronic Supplementary Material 1 (Table S9).

The analysis of the hypothesized model showed two simple indirect effects (Table 2, see also Electronic Supplementary Material 1, Table S10). First, a higher level of relationship satisfaction among target persons (T1) was related to target persons perceiving higher levels of negative control (T2), which in turn predicted *lower SB time* among target persons (T3). The indirect effect coefficient was significant, $b = -0.502$, $SE = 0.113$, 95% CI [-1.027, -0.142], $p = .007$. Second, partners' reports of lower levels of relationship satisfaction (T1) predicted target persons' reporting higher levels of perceived negative control (T2). In turn, higher levels of target persons' perceived negative social control predicted *lower levels of target persons' SB* (T3). The respective indirect effect coefficient was significant, $b = -0.268$, $SE = 0.151$, 95% CI [0.048, 0.668], $p = .011$.

Analyses yielded one additional direct effect, explaining partners' SB (T4): a high level of relationship satisfaction among partners (T1) was associated with them spending *more time on SB* (T3). Direct effects of predictors on proposed mediators involved two positive associations of target persons' relationship satisfaction (T1) with their own and their partners' perceived positive control (T2). Higher levels of partners' relationship satisfaction (T1) predicted lower perceived negative control among target persons.

The sensitivity analysis, controlling for sociodemographic variables (T1) of target persons and partners, the type of relationship (1 = romantic vs. 0 = other), and the effects of the experimental group assignment, indicated a pattern of effects similar to those obtained in the hypothesized model (Electronic Supplementary Material 1, Tables S11-S13). Thus,

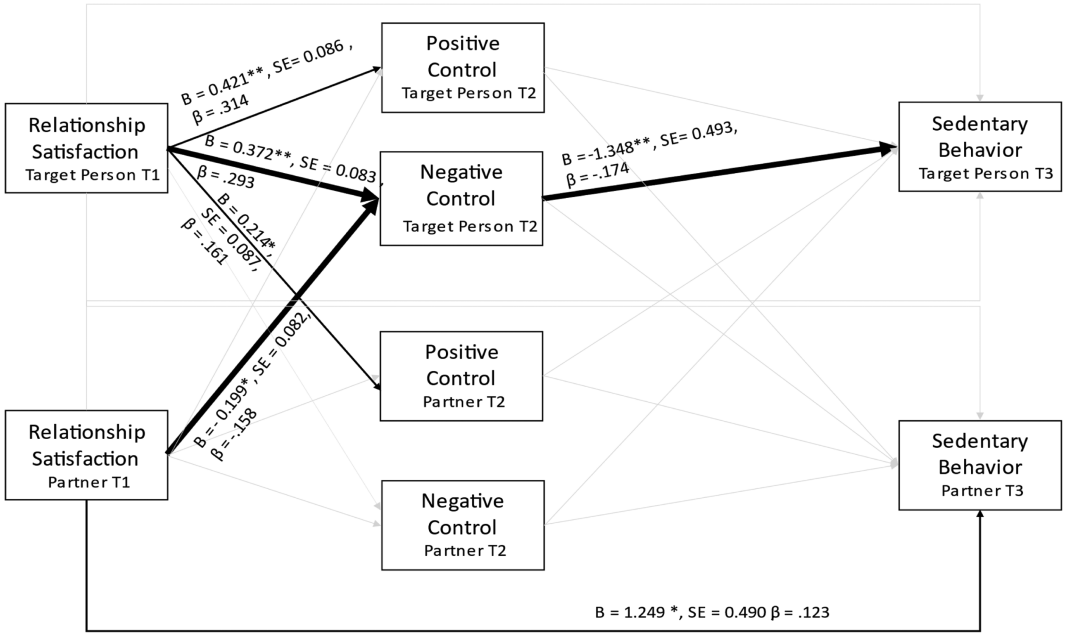

Fig. 2. Direct effects for the "Control → Relationship Satisfaction → SB Time" mediation model.** $p < .01$; * $p < .05$. Only significant effect coefficients are presented along solid lines. Significant indirect effects are marked with bold lines. Grey lines represent direct effects that were not significant. T1 = Time 1, the baseline; T2 = Time 2, 8 weeks after T1; T3 = Time 3, 8 months after T1. Residuals of all predictors, mediators, and the outcome variables were assumed to covary (for clarity, covariances are not displayed in Figure 2).

Table 2 Direct effects for the "Relationship Satisfaction → Control → Sedentary Behavior Time" Mediation Model.

Direct associations between the variables in the model	*B*	*SE*	*β*	*p*
Relationship Satisfaction (TP, T1) → Positive Control (TP, T2)	**0.421**	**0.086**	**.314**	**<.001**
Relationship Satisfaction (TP, T1) → Positive Control (P, T2)	**0.214**	**0.087**	**.161**	**.014**
Relationship Satisfaction (TP, T1) → Negative Control (TP, T2)	**0.372**	**0.083**	**.293**	**<.001**
Relationship Satisfaction (TP, T1) → Negative Control (P, T2)	0.117	0.081	.095	.149
Relationship Satisfaction (TP, T1) → Sedentary Behavior (TP, T3)	-0.348	0.531	-.035	.512
Relationship Satisfaction (TP, T1) → Sedentary Behavior (P, T3)	-0.281	0.504	-.027	.578
Relationship Satisfaction (P, T1) → Positive Control (TP, T2)	-0.021	0.085	-.016	.806
Relationship Satisfaction (P, T1) → Positive Control (P, T2)	0.126	0.087	.095	.145
Relationship Satisfaction (P, T1) → Negative Control (TP, T2)	**-0.199**	**0.082**	**-.158**	**.015**
Relationship Satisfaction (P, T1) → Negative Control (P, T2)	0.107	0.081	.088	.186
Relationship Satisfaction (P, T1) → Sedentary Behavior (TP, T3)	0.087	0.516	.009	.866
Relationship Satisfaction (P, T1) → Sedentary Behavior (P, T3)	**1.249**	**0.490**	**.123**	**.011**
Sedentary Behavior (TP, T1) → Sedentary Behavior (TP, T3)	**0.622**	**0.043**	**.619**	**<.001**
Sedentary Behavior (P, T1) → Sedentary Behavior (P, T3)	**0.651**	**0.037**	**.699**	**<.001**
Positive Control (TP, T2) → Sedentary Behavior (TP, T3)	0.805	0.485	.110	.097
Positive Control (TP, T2) → Sedentary Behavior (P, T3)	-0.823	0.460	-.108	.074
Positive Control (P, T2) → Sedentary Behavior (TP, T3)	-0.073	0.508	-.010	.886
Positive Control (P, T2) → Sedentary Behavior (P, T3)	0.404	0.482	.053	.402
Negative Control (TP, T2) → Sedentary Behavior (TP, T3)	**-1.348**	**0.493**	**-.174**	**.006**
Negative Control (TP, T2) → Sedentary Behavior (P, T3)	0.387	0.468	.048	.408
Negative Control (P, T2) → Sedentary Behavior (TP, T3)	-0.288	0.533	-.036	.589
Negative Control (P, T2) → Sedentary Behavior (P, T3)	-0.078	0.506	-.009	.878

Values of direct and indirect effect estimates presented in bold are significant at $p < .05$. Each bootstrap was based on 10,000 repetitions. BCI = Bias-corrected confidence intervals. BCI that do not include zero indicate a significant indirect effect. T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; TP = Target Person; P = Partner.

the robustness of the findings was confirmed. Two indirect effects obtained in the total sample were also significant in sensitivity analyses (Electronic Supplementary Material 1, Table S12).

The two-group model analysis, comparing romantic vs. non-romantic dyads, showed that the model assuming all direct, and indirect effects were equal across the groups yielded good model-data fit (Electronic Supplementary Material 1, Table S14). The more parsimonious model, assuming that the direct and indirect effects are equal across the two types of dyads, was accepted [34]. This model showed a pattern of associations similar to those obtained in the hypothesized one-group model (Electronic Supplementary Material 1, Table S15).

Discussion

This prospective study indicated an intriguing pattern of associations among relationship satisfaction, perceived positive and negative control, and accelerometer-assessed sedentary behaviors in dyads involving two adults who were family, friends, or in a romantic relationship. The study yields partial support for one of the formulated hypotheses based on two frameworks: the dyadic relationship factors and health [14] and the DHIM [16]. We found that higher relationship satisfaction of target persons and lower satisfaction of partners were linked with target persons' reports of (relatively) higher use of negative social control by the partner, and, in turn, lower SB time among target persons. The "social control → relationship satisfaction → SB time" hypothesis was not confirmed.

Previous research indicated small unfavorable effects of negative social control on engagement in health-promoting behaviors [8]. Our findings show that these effects should be considered in the context of the relationship satisfaction in the dyad and the levels of perceived negative control. In particular, the indirect effects in our study have to be considered in the following context: (1) even those participants who were less satisfied reported moderate satisfaction with the relationship; (2) the "high levels" of the perceived use of negative control strategies meant that the participant reported perceiving an occasional use of negative control by the other person in the dyad. In line with the DHIM [16], it seems plausible that a moderately satisfied partner in such a dyad might use some negative control to influence the target person's behavior, whereas the satisfied target person will perceive some negative social control and will comply with their partner's wishes to secure the partner's engagement with the relationship.

As suggested by Gleason [21], dyads in which both members intend to change their behavior may feel that their shared intentions legitimize the use of negative control and may benefit from this type of social control. In the present study people intending to participate in an intervention enhancing PA were enrolled (with at least target persons intending to increase their PA). Thus, as it might be expected, both participating dyad members reported at least moderate levels of intention to reduce their SB as well. The intention to change SB may have been a context in which perceived negative control facilitated target persons' behavior change. We found that target persons' perceived positive social control (T1) was related to lower SB time in partners 6 months later (T3). The perceptions of the use of positive control strategies indicate that a target person reported their partner reminding them of active breaks, making suggestions or dropping hints to reduce SB, or praising and complimenting a reduction of SB. Engaging in such control actions by the partners may require their awareness of time spent on SB by the other person in the dyad, possibly partners' awareness of their own SB time, and engaging in modeling of SB reduction. Our findings are consistent with the results obtained in research on social support provision. Berli et al. [38] have found that among romantic partners, higher daily support provision to another person in a dyad was associated with higher own objective moderate-to-vigorous PA levels.

The indirect effects were found for SB of target persons only. This may be explained by the specific nature of the enrolled dyads. One dyad member was identified as the target person, either because they declared that their PA levels were below the recommended PA thresholds [24], or that they were recommended by a specialist to increase their PA levels due to a chronic illness, and reported at least moderate intentions to initiate regular PA. Thus, the SB time reduction was most likely to occur in target persons.

Besides hypothesized mediation effects, it is possible that relationship satisfaction may act as a moderator of effects of social control on health behavior, as suggested in the contextual model [39]. Among dyads with low relationship quality, both positive and negative social control may lead to unfavorable changes in health behaviors [39]. Previous studies conducted among romantic dyads indicated that people with high relationship quality report more beneficial behavioral outcomes of social control than those in less satisfied dyads [17]. Future research investigating the role of relationship satisfaction should involve dyads with a high variation of relationship quality and test the competing mediation and moderation models. Participants enrolled in our study reported high levels of relationship satisfaction, therefore the moderator hypothesis could not be tested as the alternative model.

As this is one of the first studies testing the indirect (mediating) associations between social control, relationship satisfaction, and behavior change in dyads [16], implications for practice may be premature. Further research assessing the two competing hypotheses in dyads is needed, for example to confirm if moderate levels of relationship satisfaction in partners may be linked to the perception of some negative control by the satisfied target persons, and, consequently, with a positive change in other health behaviors.

The present study has several limitations. The majority of participants were people with higher education and medium or higher economic status, which limits any generalizations. The findings cannot be generalized to individuals with weak intentions to exercise, or to dyads that are dissatisfied with their relationship. In contrast to the majority of previous studies [8], we did not focus exclusively on romantic relationships but included other dyads who were family members or close friends as well. Triaxial hip-worn accelerometers were used to capture SB, whereas more preferable devices would involve instruments allowing for a better differentiation between sitting, standing, and light-intensity PA. Although sensitivity analyses indicated that the associations obtained in the hypothesized models were similar after controlling for assignment to the experimental condition, further indirect effects of the intervention on the mediators/dependent variables are possible. Another limitation refers to a lack of

testing for complex underlying social exchange or self-regulation processes, that may explain health behavior change.

Conclusions

Among dyads participating in an intervention to increase PA, both higher levels of satisfaction with the relationship among target persons and (relatively) lower levels of satisfaction among partners were related to (relatively) higher negative control perceived by the target persons. In turn, the (relatively) higher levels of negative control were related to better behavioral outcomes in target persons. Findings held for dyads in romantic and other close relationships, with family or friends. Overall, participants reported moderate-to-high relationship satisfaction and low-to-moderate perceived negative control.

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Compliance with Ethical Standards

Authors' Statement of Conflict of Interest and Adherence to Ethical Standards

Conflict of interest Authors Maria Siwa, Zofia Szczuka, Anna Banik, Ewa Kulis, Monika Boberska, Dominika Wietrzykowska, Nina Knol, Anita DeLongis, Bärbel Knäuper, and Aleksandra Luszczynska declare that they have no conflict of interest.

Research involving human participants and/or animals All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committees and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all participants included in the study.

Transparency Statement

1. Study registration: This study reports secondary findings of a randomized controlled trial pre-registered at ClinicalTrials.gov (#NCT03011385).

2. Analytic plan: The analysis plan was not formally pre-registered.

3. Data availability. De-identified data from this study are not available in a public archive. For research purposes, de-identified data from this study can be obtained from the corresponding author.

4. Analytic code availability. Analytic code used to conduct the analyses presented in this study are not available in a public archive. Analytic codes used to conduct the analyses can be obtained from the corresponding author.

5. **Materials availability**. Materials used to conduct the original randomized control trial (including the protocol and inttervention/education procedures) are publicly available at the Open Science Framework platform (https://osf.io/68gp2/). The remaining materials can be obtained from the corresponding author.

CRediT Author Statement

Maria Siwa: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Visualization, Writing—original draft, Writing—review and editing.

Zofia Szczuka: Data curation, Investigation, Project administration, Resources, Visualization, Writing—review and editing.

Anna Banik: Data curation, Investigation, Project administration, Resources, Writing—review and editing.

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Dominika Wietrzykowska: Data curation, Investigation, Project administration, Resources, Writing—review and editing.

Nina Knoll: Conceptualization, Formal analysis, Methodology, Writing—review and editing.

Anita DeLongis: Conceptualization, Writing—review and editing.

Bärbel Knäuper: Conceptualization, Writing—review and editing.

Aleksandra Luszczynska: Conceptualization, Funding acquisition, Methodology, Software, Supervision, Validation, Writing - original draft, Writing—review and editing.

Supplementary Material

Supplementary material is available at *Annals of Behavioral Medicine* online.

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Publikacja dotycząca Badania 2

Uniwersytet SWPS

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Your submission ANBM-D-24-00007R1

2 wiadomości

Krista W. Ranby <em@editorialmanager.com> 5 września 2024 21:03
Odpowiedź do: "Krista W. Ranby" <krista.ranby@ucdenver.edu>
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Ref.: Ms. No. ANBM-D-24-00007R1
Positive and negative parental social control, relationship satisfaction, and sedentary behavior in parent-child dyads
Annals of Behavioral Medicine

Dear Ms Siwa,

Thank you for the time you took with revising the manuscript. Reviewers again felt the design and size of the dyadic sample were strengths. They also believed that the discussion of findings was improved. Unfortunately, I still have major concerns that prevent me from accepting the manuscript for publication. I have spent a lot of time with the revised manuscript to understand what we learn from this study and I am concerned about findings that aren't consistent with theory and are not replicated at different time points.

Big picture concerns.

1. In the figures, parent positive control T1 predicts child sed beh T3 but parent positive control T2 does not predict child sed beh T3. As these effects are part of a larger model, I looked for the bivariate associations and did not find them in supplemental table 1, 2, or 3. A revision must include a correlation table that contains all variables that are in the model analyses and shows all bivariate correlations. The revision said that some of the correlations were omitted because they would violate the assumption of independence but I disagree. You can correlate one parent measure with one child measure using a Pearson r. In this case, the dyad is the unit of analysis. I don't see any need for showing some of the associations as ICC and some as r and doing so makes the results more difficult to follow. Further, these bivariate correlations should not have anything partialled out. It is confusing for the reader if some of the correlations have SB T1 partialled out, for instance. This can be done in the larger models if you make a case for wanting to predict residualized change scores (SB at T3 controlling for SB at T1) but the correlation matrix should not include partial correlations. For measures of SB, I see that you also controlled for accelerometer wear time. Reviewer 1 believed this was inappropriate to do. I don't feel I can adequately judge this without understanding the scores on the accelerometer wear time variable and how they related to sedentary behavior. If you choose to control for accelerometer wear time in your measurement of SB, please explain this in the measures section and give justification for this approach. Then it will be understood that all analyses with SB are controlling for accelerometer wear time. It is currently unclear if this is the case (e.g., attrition analyses).

2. I still have concerns about the presentation of these two models in that I don't believe these data can tell us which mediation model is most correct. And the two models tell different stories about whether parent social control affects child sedentary behavior. I think you should pick one model that best represents your theory and present it. The data cannot reveal which construct is M vs. X in a mediation model. Although you state that you aren't testing causal models, using mediation analysis presumes a causal theory. In addition, it is not completely clear when constructs at prior time points are controlled for. When doing this (e.g., including SB at T1 as a predictor of SB at T3), other predictors of SB at T3 in the model are predicting change from T1 to T3. This needs to be clarified and justified with theory and clear in the discussion of results. Further, an aim of predicting change in SB from T1 to T3 seems a bit odd when previous findings from these data suggest no overall change. Relatedly, when effect sizes are discussed, it should be clear what predictors were included (e.g., page 16, R2=.266, is this including the variance in SB T3 that is explained by SB T1?).

3. I also have a new concern with the measurement of social control. It is my understanding that social control is typically assessed as a frequency and in fact, this is the way it was discussed in the manuscript. In the measures section, however, it is discussed as an attitude measure (does your parent do this? 1=totally disagree to 4= totally agree). This measurement is not consistent with the cited articles. Lewis et al., (2004) assess on a scale of 1=never to 7=at least once a day. Can you provide a citation for this exact measure or evidence for how similar this measure is to a frequency measure?

4. Models show that more positive parent relationship satisfaction relates to lower parent SB and more positive child relationship satisfaction relates to higher parent SB. Further, parent relationship satisfaction and child relationship satisfaction are positively correlated. These associations are confusing and because the pairwise associations were not reported or did not replicate these associations (parent relationship satisfaction T1 was not correlated with parent SB T3), I am concerned about their accuracy/replicability. Similarly, greater child perceived control predicts greater child relationship satisfaction, greater parent control predicts lower child relationship satisfaction, yet child and parent control measures are positively correlated.

I can understand that this feedback is not what you were hoping for. I would invite a major revision that addresses these concerns, however, this is no guarantee that the paper will be accepted following the revision. You are also free to withdraw your manuscript and submit it elsewhere. If you do revise and resubmit, pay attention to the page limits and make sure that the manuscript can be understood without supplemental material.

*As indicated in the Author Guidelines adopted in February 2022, all manuscripts published in Annals of Behavioral Medicine require a number of statements and additional data that may be missing. I would like you to make sure that all of these are in the revised manuscript you submit.
1. Open science disclosure statements. Include these on the Title Page. Examples can be found below the signature line.
2. Conditions for authorship. Include a CREDiT statement on the Title Page. Examples can be found

below the signature line.
3. Required Description of Sample Sociodemographic Characteristics. Include this in Methods and/or Results section.
4. Reporting the dates of data collection. Include this in Methods section.
Please refer to the Author Guidelines for how to include each of these in your revised manuscript.
https://academic.oup.com/abm/pages/general_instructions#ms

If you choose to revise your submission:
1. Complete your revised manuscript, highlight any changes in the revised text using red font to allow for easy recognition of modifications, and write a cover letter that provides a detailed list of responses to each of the comments. In your cover letter, please include the specific text that has been added or deleted in addressing the reviewers' points. Also put your responses to the reviewers in the "response to reviewers" textbox.
2. Ensure that the paper is in the format specified in the Publication Manual of the American Psychological Association (7th ed.) and that the references conform to AMA style (please access the Instructions for Authors at https://academic.oup.com/abm/pages/general_instructions for more details).
3. Please make sure to submit your editable source files (i.e. Word, TeX).
4. Go to https://www.editorialmanager.com/anbm/ and log in as an Author. When you reach the main menu, you will find your submission record by clicking on "Submissions Needing Revision."
5. Click "Submit Revision" and begin following the same steps you did in your original submission.
6. In submitting your revised files, please attach your revised manuscript, new cover letter and any revised figures or tables. Please ensure that you have removed earlier versions of your files so that this submission contains only the most recent version of your documents.

If you choose not to revise your submission:
1. Please go to https://www.editorialmanager.com/anbm/, log in and click on "Submissions Needing Revision.", and select "Decline to Revise" on the left side of the page.

Please note that resubmitting a revised manuscript does not guarantee eventual acceptance for publication, as this decision will depend upon additional evaluation by external reviewers as well as my own assessment. Finally, if you do decide to revise and resubmit your paper, you must do so by 04 Dec 2024 or it will be withdrawn from further consideration.

Sincerely,
Krista W. Ranby
Associate Editor
Annals of Behavioral Medicine

Comments from the Editors and Reviewers:

Reviewer #1: This study examined several models on the links between relationship quality, social control, and sedentary behavior in parent-child dyads. This study is well-designed with a relatively large sample of dyads. I thank the authors for a very thorough and thoughtful revision that is now more consistent with the broader literature. All of my major points were addressed. The one issue I disagree with the authors is to "correct" the raw correlation tables by statistically controlling for what is perceived as a major confound. I would encourage the authors to include the raw associations and maybe footnote major differences that occur once corrected. This suggestion would be much more transparent and consistent with Open Science practices.

Reviewer #2: The authors have addressed my concerns with the manuscript. I particularly appreciated the inclusion of additional analyses in electronic supplementary material and the bolstering of the explanation of the findings in the discussion (in response to my comment #2).

Reviewer #3: This revision was very responsive to mine and the other reviewers' comments. The additional theoretical framing added to the introduction was important for developing the rationale for supporting the study aims. I particularly valued the effort to extend the discussion, adding in rich consideration of the findings.

My only small recommendation is that sometimes I was lost in the distinction between child and parent rating of social control (because of the shifting language).
For example, the authors sometimes use the following phrases: child reports of positive or negative parental social control; received positive/negative social control; positive parental social control received by children; child-received positive control etc.... There is a lot to hold onto in this paper, and it would simplify comprehension to select a phrase and continue to use it consistently.

Annals of Behavioral Medicine

Positive and negative parental social control, relationship satisfaction, and sedentary behavior in parent-child dyads

--Manuscript Draft--

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Abstract:	Background: The close relationship processes and health model and the dyadic health influence model posit that relationship beliefs (e.g., relationship satisfaction) and influence strategies (e.g., provision and receipt of positive and negative social control) mediate health behavior change. However, evidence for such mediation in parent-child dyads is limited. Purpose: This study investigated two competing hypotheses: (1) parental social control forms indirect relationships with sedentary behavior (SB), via relationship satisfaction acting as a mediator; or (2) relationship satisfaction forms indirect relationships with SB, with social control operating as a mediator. Methods: Data from 247 parent-child dyads (9–15 years old children) were analyzed using manifest mediation models. SB was measured with GT3X-BT accelerometers at Time 1 (T1; baseline) and Time 3 (T3; 8 months following baseline). Relationship satisfaction and social control were assessed at T1 and Time 2 (T2; 2 months following baseline). Results: Child receipt of positive parental control (T1) was associated with higher

Positive and negative parental social control, relationship satisfaction, and sedentary behavior in parent-child dyads

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Transparency Statement

1. Study registration: This study reports secondary findings of a randomized controlled trial pre-registered at ClinicalTrials.gov (#NCT02713438).
2. Analytic plan: The analysis plan was not formally pre-registered.
3. Data availability. De-identified data from this study are publicly available at the Open Science Framework platform (https://osf.io/bk24c)
4. Analytic code availability. Analytic code used to conduct the main analyses presented in this study are publicly available at the Open Science Framework platform (https://osf.io/bk24c/).
5. **Materials availability**. Materials used to conduct the original randomized control trial (including the protocol and intervention/education procedures) are publicly available at the Open Science Framework platform (https://osf.io/vk2qe/).
The remaining materials can be obtained from the corresponding author.

CRediT Author Statement

Maria Siwa: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Visualization, Writing—original draft, Writing—review and editing.
Zofia Szczuka: Conceptualization, Data curation, Investigation, Methodology, Project administration, Resources, Visualization, Writing—review and editing.
Anna Banik: Conceptualization, Data curation, Investigation, Methodology, Project administration, Resources, Writing—review and editing.
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Aleksandra Luszczynska: Conceptualization, Formal analysis, Funding acquisition, Methodology, Resources, Supervision, Validation, Writing—review and editing.

Abstract

Background: The close relationship processes and health model and the dyadic health influence model posit that relationship beliefs (e.g., relationship satisfaction) and influence strategies (e.g., provision and receipt of positive and negative social control) mediate health behavior change. However, evidence for such mediation in parent-child dyads is limited.

Purpose: This study investigated two competing hypotheses: (1) parental social control forms indirect relationships with sedentary behavior (SB), via relationship satisfaction acting as a mediator; or (2) relationship satisfaction forms indirect relationships with SB, with social control operating as a mediator.

Methods: Data from 247 parent-child dyads (9–15 years old children) were analyzed using manifest mediation models. SB was measured with GT3X-BT accelerometers at Time 1 (T1; baseline) and Time 3 (T3; 8 months following baseline). Relationship satisfaction and social control were assessed at T1 and Time 2 (T2; 2 months following baseline).

Results: Child receipt of positive parental control (T1) was associated with higher relationship satisfaction in both children and parents (T2), which in turn were related to lower and higher parental SB at T3, respectively. Parental provision of positive control (T1) was related to lower relationship satisfaction in children (T2), and higher SB (T3) in children and parents. Furthermore, lower provision of negative control (reported by parents at T1) predicted higher levels of relationship satisfaction among parents (T2), which in turn predicted more SB time among parents (T3).

Conclusions: Provision and receipt of positive social control may form distinct associations with relationship satisfaction and SB in parent-child dyads.

Keywords Social control; Relationship satisfaction; Sedentary behavior; Parent-child dyads

Adults and adolescents spend over eight hours engaged in sedentary behaviors (SB) during waking hours [1,2]. Spending a long time on sedentary activities, which are characterized by an energy expenditure of ≤ 1.5 metabolic equivalents, remains a significant global concern [3,4,5]. This is due to the negative effects of SB on physical health, mental health, and quality of life across the lifespan [3,4,5]. Understanding the factors that contribute to SB among children and adults is crucial for developing effective interventions that promote health and prevent chronic diseases. In addition to individual-level determinants, social processes have a potential to co-determine energy expenditure behaviors, like SB [6].

Theoretical Background for the Links Between Social Processes and Sedentary Behavior

A framework for investigating dyadic relationship processes and health emphasizes the associations between social processes and health-related behaviors [7,8]. This approach [7,8] suggests that social process variables (e.g., social control) may predict relationship variables (including relationship satisfaction) which, in turn, predict health outcomes, such as health behaviors or physiological states. The framework assumes that these variables may also be chained in reverse order, namely, relationship factors may predict social process variables, which in turn explain health outcomes [7]. Other frameworks and models explaining health behaviors in a dyadic context, such as the dyadic health influence model (DHIM), make similar assumptions [9]. The DHIM proposes indirect pathways through which beliefs about the relationship (such as relationship satisfaction) and social influence strategies (such as the use of social control) explain health behaviors [9]. Specifically, the use of influence strategies by one person in the dyad may predict the relational beliefs of the other person in the dyad and, in turn, their health behaviors. For instance, the use of social influence strategies by one person in the dyad may trigger relationship-related thoughts, such as relationship satisfaction in one or both members of the dyad. Perceiving a relationship as

satisfactory may increase the likelihood of the uptake of health behavior (e.g., reducing SB) because of the desire to maintain a good quality relationship [9].

Social process variables, indicated by both the DHIM and the framework for investigating dyadic relationship processes and health [7,8], include social control as a key factor. The concept of social control, developed in the context of health behavior change and health outcomes, relates to any attempt to influence the other person's health or health behaviors [10,11]. Positive social control refers to the use of persuasion, rational logic, and reward, while negative social control refers to expressions of negative emotions or attempts to induce negative emotions in the target person to influence their behavior [12,13].

In line with the framework for investigating dyadic relationship factors and health [7], higher relationship satisfaction may promote healthier behaviors (such as SB time reduction), for example, to please the dyadic partner. Lewis and Rook's [10] approach to social control and the DHIM [9] in turn suggest that social control strategies, in particular positive social control, may prompt a healthier lifestyle (e.g., a reduction of SB time) directly and indirectly, via relationship satisfaction. Conversely, negative social control is likely to trigger a lower relationship satisfaction, and it may be inefficient in prompting the adoption of a healthy lifestyle [9]. Importantly, approaches such as the DHIM [9], the framework for investigating dyadic relationship processes and health [7], as well and Lewis and Rook's [10] approach to social control were developed in the context of dyadic processes and health behaviors and health-related outcomes, which is crucial for the present study. Although other models of social control processes in dyads (e.g., [14]) also suggest links between social control and relationship satisfaction, they do not explain health behavior processes.

Associations Between Relationship Satisfaction, Social Control, and Sedentary Behavior in Parent-Child Dyads

Existing research on social control and sedentary behaviors in parent-child dyads focuses on direct associations between the use of social control by parents and SB of children or adolescents. For example, Nakamura et al. [15] found no direct associations between social control, as self-reported by parents, and screen time, as self-reported by adolescents. However, higher levels of parental social control moderated the relationship between parents' sedentary screen time and their children's sedentary screen time. Although the findings reported by Nakamura et al. [15] were based on a large sample (1,945 dyads), the applied design was cross-sectional, SB was self-reported, and the applied index of social control did not allow for differentiating between positive and negative social control. Contrary to the Nakamura et al.'s [15] study, other research usually focused on *received* social control reported by children, whereas parental reports of *provision* of social control were rarely considered [16].

In general, research linking various types of parental control strategies and SB of children or adolescents yielded mixed findings [17, 18]. Furthermore, research conducted to date has not tested full dyadic models, with predictors and outcomes assessed in both dyadic partners. Instead, the focus has typically been on SB of children/adolescents as an outcome. Finally, research to date yielded mixed findings regarding the associations of positive and negative social control with the adoption of health behaviors [11, 19], however, this research mostly focused on adult-adult dyads.

Existing studies testing the associations between relationship quality and SB in parent-child dyads have also yielded mixed findings. For example, Jake-Schoffman et al. [20] found that higher parent-child relationship quality (reported by adolescents) was unrelated to SB in adolescents, whereas Sampase et al. [21] suggested that adolescents' reports of poorer parent-child relationship quality predicted longer SB time among adolescents. Additionally,

studies addressing health behaviors in adolescent-parent dyads usually accounted for relationship satisfaction and behaviors assessed in adolescents, but not parents [20, 21].

Much research investigating full dyadic associations between social control, relationship satisfaction, and SB (all measured in both dyadic partners) has been conducted in adult-adult dyads, with the target persons diagnosed with a chronic illness, such as cardiovascular disease or type-2 diabetes [19]. Longitudinal findings reported by Siwa et al. [19] suggested that lower baseline levels of relationship satisfaction among partners predicted target persons' reports of higher levels of negative control from partners, which in turn predicted lower SB time among target persons. However, it may be that the patterns of associations differ substantially in parent-child dyads as compared to adult-adult dyads. Parent-child relationships are typically asymmetrical due to the parent's role as a caregiver and authority figure [22]. Moreover, parents often serve as "gatekeepers" in their children's health behaviors: They control access to various resources and opportunities that can influence their children's activities and habits in ways not as pronounced in adult romantic relationships [23]. On the other hand, adolescents navigating the developmental stage of increased independence [24] may perceive parental attempts to control their behaviors as actions impeding their freedom of choice [25, 26] and thus report lower satisfaction with the relationship with a parent or reactance to parental suggestions to reduce SB.

Study Aims

This study aimed to test longitudinal associations between positive and negative parental social control (provided by parents and received by their children), relationship satisfaction, and SB time in dyads of parents and their 9- to 15-year-old children. The tested models and study methods are parallel to those used in our study of adult-adult dyads [19] and explore potential differences and similarities in the patterns of associations. A limited amount of research used prospective designs to explain the associations between any social

predictors and SB at follow-ups, controlling for baseline behavior. Moreover, according to the transtheoretical model of behavior change [27] behavior patterns should be observed for at least 6 months to establish if a behavioral pattern is maintained. Thus, our study accounts for the observation of SB for the period > 6 months. In line with the DHIM [9] and the framework for investigating dyadic relationship factors and health [7], we tested two competing mediation models. The first model assumed that parents' provision of positive and negative parental social control, as well as their children's receipt of positive and negative parental social control (Time 1; T1), would be associated with parental and child SB (measured at Time 3, T3; 8 months after T1) indirectly, with parental and child relationship satisfaction (Time 2, T2; 2 months after T1) mediating these associations. The second model assumed that relationship satisfaction (T1; parents and children) would be associated with SB (T3; parents and children) indirectly, with positive and negative parental social control (T2; provision and receipt) mediating these associations.

Method

Procedures

This study reports secondary findings from a randomized controlled trial registered with ClinicalTrials.gov (xxx -blinded for review). The primary objective of the trial was to investigate the effects of three types of planning + education interventions delivered to parent-child dyads, compared to a control condition (SB, physical activity [PA], and a healthy diet education). Regarding the main outcomes evaluated in the trial, the PA planning interventions did not affect SB in children, but there was a decrease in SB time observed among parents who participated in two types of PA planning interventions (the collaborative "we-for-us" and individual "I-for-me" planning) at a 1-week follow-up [28]. Children in the dyadic ("we-for-me") planning condition showed reduced moderate-to-vigorous PA compared to the control condition at the 36-week follow-up [29]. Besides the effects of the

intervention on PA and SB [28, 29] observed in this trial, the roles of other social and cognitive predictors were not tested.

All parents and their children took part in identical education sessions. The education addressed SB definitions and patterns, SB health consequences, and ways to break SB bouts and reduce overall SB time. Examples of ways to reduce SB were adapted to the age of the participants (e.g., children were given tips on how to reduce SB while at school) [28, 29]. No behavior change techniques addressing relationship satisfaction or social control were used.

A T1 self-report was followed by 6 days of accelerometer-based SB measurement, and a Time 2 (T2) self-report assessment, taking place at a 2-month follow-up. T3 was conducted 8 months after T1 and included self-reports, followed by 6 days of SB assessment (with accelerometers). Data were collected individually (each member of the dyad completed questionnaires separately) during face-to-face meetings of a dyad with an experimenter.

The inclusion criteria were: (1) child age between 10 and 14 years old (student of 4^{th} to 8^{th} grade of primary schools); however, in order to mitigate the potential for feelings of exclusion among children in the same school grade, participants who were either 9 years old (n = 11) or 15 years old (n = 2) at the initial assessment were also included; (2) as declared by parents during the recruitment, child PA levels prior to the enrollment were below the thresholds indicated by the World Health Organization [(WHO) 5, 30]; (3) children and parents expressed an intention to increase their PA, as declared during the recruitment.

Data were collected between February 2016 and March 2022 in 18 urban locations and nine rural locations in South-Western Poland. Participants were recruited in schools during parent-teacher meetings, via social media, or on websites of non-governmental organizations. Potential participants were informed about the study's aims and procedures. After familiarizing themselves with the study information materials, participants were screened for eligibility. Parents and children were asked to provide informed consent about

the study participation; parental consent for the child to participate was also obtained. The study was approved by the Ethics Committee at the first author's institution. There was no financial compensation for participation; participants received a thank-you gift (value 5-10 EUR) after each measurement.

Participants

Overall, 463 parents and 451 children were screened for eligibility; 261 parents and 204 children either did not meet the inclusion criteria or decided not to take part in the study. At Time 1 (T1), participants were $N = 247$ parent-child dyads. Time 3 measurement (T3; 8-month follow-up) was completed by $n = 176$ dyads, indicating that the total longitudinal dropout was 28.74%.

The baseline sample of parents or legal guardians (85.8 % women) were 29 to 66 years old ($M = 41.00$ years; $SD = 4.87$). The study followed the principle of selecting the parent who spent more time with the child to participate alongside their child. The involved children (48.6% girls) were 9 to 15 years old ($M = 11.37$ years; $SD = 1.22$). The 9-year-olds ($n = 11$) who participated in the study demonstrated advanced cognitive and social development (school maturity, evaluated during the enrollment in 1st grade) and they commenced their formal education at an earlier age than their peers.

Among the children, 57.9 % had normal body weight according to IOTF BMI cut-offs [31], 38.9 % had overweight or obesity, and 3.2% had underweight. The majority of parents (56.7 %) had overweight/obesity, 40.5% of parents had normal body weight, and 2.8% had underweight. The majority of parents (74.2 %) had completed higher education; 23.4 % of parents had a high school or vocational diploma; 2.0% of parents reported primary education. Almost half of the parents (48.0%) perceived their economic status as similar to the economic status of the average family in Poland, 44.2% of parents indicated that their economic status was above the average; 7.8% of parents described their economic situation as worse than the

economic status of the average family in Poland. At T1 87.4% of parents declared that they exercised < 150 min per week and thus did not meet PA recommendations [5, 30].

Measures

Means, standard deviations, and internal consistency coefficients (Cronbach's alpha values) are presented in Supplementary Table 1.

Sedentary Behavior Time (T1 and T3)

Sedentary time data were obtained using ActiGraph GT3X-BT accelerometers (hip worn). Children and their parents were instructed on device use for the following six days (during their waking hours). Data obtained from each device were used in the analyses only if it had been worn for at least eight hours per day, for a minimum of three days during the corresponding time period [32]. Data scoring methods were based on algorithms: the Freedson-VM3 [33] and the Freedson-Adult [34] for parents, and Freedson-Children [35] and Evenson-Children [36] for children, in Actilife software. Non-wear time was calculated using an epoch-based algorithm based on Choi et al. [37]; 10-second epochs were used to better distinguish between sedentary behaviors and physical activity [38]. Sedentary time was calculated as the average minutes of sedentary behavior per day (with the number of minutes of wearing the accelerometer controlled in analyses). Data obtained during the first valid wear day at T1 was excluded to reduce the initial reactivity to accelerometer-based assessment [39].

Parental Provision/Child Receipt of Positive and Negative Social Control (T1 and T2)

Seven items were used to assess children's reports of positive or negative parental social control to encourage SB reduction. Parents, in turn, answered in terms of the provided information about the social control techniques they applied to influence their child SB. Positive social control was assessed with four items based on measures proposed by Lewis and Butterfield [40] and Thorpe [41]: "How does your parent influence (motivate) you to

limit the time you spend sitting?/ How do you influence (motivate) your child to limit the time they spend sitting: (1) repeatedly reminding them to take active breaks, (2) making suggestions or dropping hints, (3) using humor, (4) praising and giving compliments." Negative social control was assessed with three items based on measures proposed by Lewis and Butterfield [40] and Thorpe [41]: "How does your parent influence you to limit the time you spend sitting?/ How do you influence your child to limit the time they spend sitting: (5) being persistent, (6) trying to make you feel guilty, and (7) saying that you would change if you cared for them." For both social control measures, the responses were provided on a 4-point scale ranging from 1 (*totally disagree*) to 4 (*totally agree*).

Relationship Satisfaction (T1 and T2)

A four-item version of the Couple Satisfaction Index (CSI-4) [42] was used to measure relationship satisfaction. Children and their parents were instructed to evaluate their mutual relationship ("Please indicate the degree of happiness, all things considered, of your relationship with your child/parent"), using such items as: "My child feels safe with me and knows he/she can count on me"/ "I feel safe with my parent and I know I can count on them" with answers ranging from 1 (*totally agree*) to 4 (*totally disagree*); "How rewarding is your relationship with your child/parent?," with answers ranging from 1 (*not at all*) to 4 *(completely*); "In general, how satisfied are you with your relationship?" with answers ranging from 1 (*not at all*) to 4 (*completely*).

Control Variables

Sociodemographic covariates used in the sensitivity analysis were: (1) age; (2) gender; (3) parent's education (elementary, vocational, high school, post-secondary, bachelor, master), (4) parent's self-reported economic status, with responses varying from 1 *(much above the average family in Poland*) to 5 (*much below the average family in Poland*). Intention to reduce SB was assessed at T1 with two items [43]: "I intend to sit for a maximum

of 5 hours (in total) a day over the next week" and "I intend to break up my sedentary behavior, at least once per hour." Responses ranged from 1 (*definitely not*) to 4 (*definitely yes*) (the correlation between the two items for children: $r = .23$, $p < .001$, $M = 2.86$, $SD = 0.64$; and for parents: $r = .29$, $p < .001$, $M = 2.88$, $SD = 0.66$).

Data Analysis

The G*Power calculator (simulating a multiple regression model) was used to conduct post-hoc calculations of the sample size. Assuming small effect sizes $f^2 = .08$ (in line with previous dyadic longitudinal research [19]), a power of .95, a Type I error rate of .05, and accounting for age and gender, the determined sample size was approximately 260 dyads.

Analyses were performed using IBM SPSS and AMOS version 28. Bivariate associations were calculated using Pearson's *r* or intraclass coefficients. In case of coefficients referring to SB time, partial correlation coefficients, controlling for accelerometer wear time were calculated (for further details see Electronic Supplement 1). To avoid interdependence bias, bivariate correlations were not calculated for two different variables assessed across two members of parent-child dyads (see Electronic Supplement 1).

Path analyses were conducted with maximum likelihood estimation. The two hypothesized models assumed that parents and their children were distinguishable and accounted for three measurement points, with the independent, mediator, and dependent variables assessed at separate time points, controlling for the T1-level of the dependent variable. T1-levels of the mediator variables were not controlled in the models to reduce the bias related to multicollinearity and to prevent a reduction of power due to a high number of parameters in the model (for a similar approach see e.g., [19]).

Several model-data fit indices were applied. A cut-off point of $\leq .08$ for the root mean square error of approximation (RMSEA) was used [44]. A cut-off point of $\geq .95$, indicating good model-data fit, was applied for the comparative fit index (CFI) and the normed fit index

(NFI) [44]. The indirect effects were evaluated with unstandardized effect coefficients, calculated with 10,000 bootstraps (95% CI).

Missing data (including data missing due to dropout at T2 and T3) were accounted for by using the full information maximum likelihood (FIML) procedure [44]. Little's MCAR test indicated that the missing data patterns were systematic, Little's χ^2 = 869,48, p =.010. Mardia's coefficient of multivariate normality indicated moderate non-normality values (17.69 for social control → relationship satisfaction → SB time model and 15.10 for relationship satisfaction → social control → SB time model).

Analytic Strategy for the Manifest Mediation Models

Models were estimated in line with recommendations for the actor-partner interdependence model with mediators (APIMeMs, [45]). The models were manifest and saturated in terms of the associations between the independent, mediator, and dependent variables, and their respective covariances (e.g., independent variables as well as the residuals of mediators and outcome variables were assumed to covary) [45]. The SB indicators at T1, assessed in children and parents, were assumed to covary and predict T3 indicators of SB measured in both dyad members. Accelerometer wear time (the average values per person per day) was controlled in analyses; wear time was assumed to covary with the SB time.

Several indirect effects were tested: (1) those with the independent, mediator, and dependent variables measured in one person; (2) those with at least one variable in the chain of 'the independent variable → the mediator → the dependent variable' measured in one person and at least one variable in this chain measured in the other person. The total effects, total indirect effects, simple indirect effects, and direct effects were calculated using the user-defined estimands function [45, 46]. To account for the dyadic interdependence, the independent variables' indicators (T1) were assumed to covary; SB indicators (T1) measured

in children and their parents were also assumed to covary. Residuals of the mediators (T2) and SB outcomes (T3) measured in both persons in a dyad were also assumed to covary.

Sensitivity analyses were conducted to assess the robustness of the findings [47]. We examined whether the pattern of associations was similar in the hypothesized model and the model controlling for the parent's and child's age and gender, parental education and economic status (T1), parent's and child's SB reduction intention, and the experimental group assignment (1 = participating in PA planning intervention, 0 = no planning intervention).

Additional analyses explored if SB time (T1) predicts positive and negative social control (T2), and, in turn, relationship satisfaction (T3). We also explored if SB time (T1) predicted relationship satisfaction (T2), and, in turn, social control (T3) in parent-child dyads (see Supplementary Tables 13-18).

Results

Preliminary Analyses: Bivariate Associations and Dropout

Bivariate correlations between study variables, means, and standard deviations are presented in Supplementary Table 1. The within-person correlations indicate that parental reports of satisfaction with the relationship with their child (T1 and T2) were associated with parents spending more time on SB (T3). Parent-provided positive control at T1 (but not at T2) was associated with more SB time (T3) among parents. Other within-person bivariate associations of control or satisfaction indicators with SB at T3 were non-significant.

Across variables, the within-persons associations between the potential predictors (assessed at T1 and T2) and the potential mediators (T2) or outcome indicators (SB at T3), were similar for predictors assessed at both T1 and T2. For example, child reports of relationship satisfaction at T1 and T2 were positively associated with received positive control at T2 (Supplementary Table 1). There were two exceptions, namely: (i) there was a significant cross-sectional association between parental relationship satisfaction (T2) and

higher provided positive control (T2), but no prospective association was found; and (ii) as already mentioned, there was a significant associatio between positive control provided by parents at T1 (but not at T2) and parental SB at T3.

Among children and their parents, analyses for T1 data showed no differences between completers and drop-outs (see Electronic Supplement 1). On average, children and their parents reported that they intended to reduce SB at T1. Intentions of parents and children were similar in strength.

Changes Over Time and Differences Between Persons in the Main Variables

For respective coefficients, *p* values, descriptive statistics and effect sizes see Electronic Supplement 1. There was no significant change in SB time from T1 to T3 among children, but there was a small reduction of SB time among parents, Cohen's $d = 0.13$. On average, children and their parents reported being satisfied with their relationships. Relationship satisfaction was higher in parents than in children, both at T1 and at T2. There was no change in relationship satisfaction between T1 and T2, neither among children nor their parents. Parents and their children did not differ in reports of negative control at T1. Parents reported higher T1 positive control than their children. At T2, both members of the dyad reported similarly low levels of negative control, but again parents reported higher levels of positive control than did their children. There was no change in reports of negative control between T1 and T2, neither among children, nor parents. Comparing T1 and T2 levels, reports of positive control did not change among children, nor among parents.

Findings for the 'Social Control → Relationship Satisfaction → SB Time' Model

The hypothesized model, calculated for $N = 247$ dyads, had an acceptable fit with $\chi^2(42) = 47.758$, $p = .250$, $\chi^2/df = 1.137$, NFI = .960, CFI = .995, RMSEA = .024 (90% CI: .000, .051). Direct and indirect associations between the independent variables (T1), mediators (T2), and the dependent variables (T3) are presented in Figure 1 and Table 1. The

values of covariance coefficients are reported in Supplementary Table 3. The variables in the model explained 26.6% variance of children's SB (T3) and 43.7% of parents' SB (T3), controlling for respective T1-levels of SB and wear time.

The analysis of the hypothesized model showed three simple indirect effects (see Supplementary Table 4). A higher level of positive parental social control received by children (T1) was related to children's higher level of relationship satisfaction (T2), which in turn predicted *lower* SB time among parents (T3); b = -6.631, SE = 2.720, 95% CI [-12973, -2.056], p = .006. A higher level of positive parental social control received by children (T1) was related to parents' higher level of relationship satisfaction (T2), which in turn predicted *higher* SB time among parents (T3); b = 5.793, SE = 2.297, 95% CI [2.095, 11.319], p = .002. Parents' reports of *lower* provision of negative control (T1) predicted *higher* levels of relationship satisfaction among parents (T2); in turn, *higher* levels of parents' relationship satisfaction (T2) predicted *higher* levels of SB among parents (T3); b = -3.630, SE = 2.069, 95% CI [-8.646, -0.358], p = .026.

The analyses conducted for the hypothesized model yielded two direct effects on SB (T3): more frequent provision of positive parental control (reported by parents; T1) was positively associated with more time spent on SB in both children and parents (T3). Additionally, more frequent provision of positive parental control (reported by parents; T1) was related to children's lower level of relationship satisfaction (T2) (Figure 1).

Sensitivity analysis, accounting for children's and parents' gender, age, parent's education, and economic status, SB intention (T1) of children and their parents, the experimental group assignment (1 = PA planning intervention, 0 = no planning intervention), and wear time of the accelerometer, indicated a similar pattern of effects, thus, supporting the robustness of the findings (Supplementary Tables 5-7).

Table 1 and Fig. 1 about here

Findings for the 'Relationship Satisfaction → Social Control → SB Time' Model

The hypothesized model, calculated for $N = 247$ dyads, had an acceptable fit, with $\chi^2(42) = 52.077$, $p = .137$, $\chi^2/df = 1.240$, NFI = .952, CFI = .990, RMSEA = .031 (90% CI: .000, .056). As the model showed no indirect effects (see Supplementary Table 9), only direct associations between the independent variables (T1), mediators (T2), and the dependent variables (T3) are presented in Figure 2 and Table 2. The values of covariance coefficients are presented in Supplementary Table 8. The variables in the model explained 25.8% variance of children's SB (T3) and 40.9 % of parents' SB (T3).

The analyses yielded three direct effects: a higher level of relationship satisfaction among children (T1) was associated with children receiving more positive and negative parental social control (T2); a higher level of relationship satisfaction reported by the parents (T1) was related to more time spent on SB among parents (T3).

Sensitivity analysis, accounting for children's and parents' gender, age, intention to reduce SB at T1, parents' education and economic status, the experimental group assignment (1 = PA planning intervention, 0 = no planning intervention), and the accelerometer wear time indicated a similar pattern of direct effects (Supplementary Tables 10-12).

Table 2 and Fig. 2 about here

Additional Findings

Results for the two additional models, 'SB Time → Relationship Satisfaction → Social Control' and 'SB Time → Social Control → Time Relationship Satisfaction,' confirm the prospective findings observed in the hypothesized models. Received positive control reported by children (T2) predicted higher relationship satisfaction in parents (T3) and children (T3) (see Supplementary Tables 13-18). Additionally, longer SB time (T1) among children was associated with lower relationship satisfaction reported by children (T3) and by parents (T3).

Discussion

This prospective study indicated a complex pattern of associations among relationship satisfaction, perceived positive and negative control, and accelerometer-assessed sedentary time in dyads of parents and their 9-15-year-old children. The findings cannot be interpreted as causal links, as our predictions are based on prospective data rather than an experimental manipulation with social control or relationship satisfaction. We found three indirect effects of different indices of social control (T1) and one direct effect of relationship satisfaction (parental reports at T1, T2) on *parental sedentary time* (T3). We found direct effect of social control (parental provision at T1) on *child sedentary time* (T3). While received positive control (children, T1) was associated with higher relationship satisfaction among children (T2), provided positive control (reported by parents; T2) was related to lower relationship satisfaction among children (T2).

Complexity of the 'Social Control' Construct in Parent-Child Dyads

Our study applied the framework for investigating dyadic relationship processes and health [7,8] and the DHIM model [9], as the conceptual background. Both approaches were developed to address social influence strategies, relationship satisfaction, and health behavior change in dyads consisting of two adults. The constructs of positive and negative social control were also developed [10] and used [11] mostly to explain health outcomes in adult-adult dyads. The complex findings for social control in parent-child dyads, observed in our study suggest that the chosen conceptual approaches [7,8,9] may be insufficient. For example, received positive social control (children, T1) was related to higher relationship satisfaction among children (T2), whereas provided positive social control (parents, T1) was associated with lower relationship satisfaction among children (T2).

Although the frameworks for social control in parent-child dyads [14, 48] focus on control--relationship satisfaction links only, they offer insights into potential subtypes of

social control. They distinguish such negative control strategies as blunt *negative pressure strategies,* involving verbal hostility or threats, less salient negative strategies involving manipulative guilt induction (parents trying to make their child feel guilty by saying that the child would change if the child cared for them [14]), *conditional negative regard* (a more subtle negative control strategy of a withdrawal of affection and support to limit unwanted behaviors [48]), and positive control strategies, such as *conditional positive regard* [14,48]. Positive conditional regard constitutes an act of subtle manipulation, with the reward being contingent on the child's achievement and the child feelings of being appreciated not as a person but only if the behavior meets the parental standards [14,49]. Consequently, it is linked to relationship dissatisfaction in children [14,49]. On the other hand, parental praise and reward may be also delivered in the form of encouragement to explore new behaviors and/or monitor one's own actions. Such parental strategies may be considered to represent a positive control strategy, which focuses on *the promotion of volitional functioning* [14] and may be considered a subtype of autonomy support [50]. One of the recent proposals of social control processes in adult-adult dyads also suggested a distinction between autonomy-supportive control strategies and autonomy-limiting control strategies [51]. Accounting for subtypes of positive and negative social control may help to explain heterogeneous effects of social control on health behaviors, observed in existing research [11] and the findings of our study.

Unfortunately, following previous research on positive social control in adult-adult dyads [19,40,41], we used a measure assuming a unidimensional construct of positive social control. Thus, our interpretation of the findings remains hypothetical and requires future research testing at least two dimensions of positive social control (i.e., positive conditional regard vs. promotion of volitional functioning) and several dimensions of negative control (e.g., blunt pressure with the presence of negative comments vs. negative conditional regard

vs. the use of nagging and other "negative" strategies to promote autonomy support) in the context of provided and received social control.

Positive Control Received by Children and Relationship Satisfaction in Parent-Child Dyads

We found that higher levels of positive parental social control received by children (T1) predicted higher relationship satisfaction among children (T2). In line with DHIM [9], children who report that their parents invest efforts to influence their behavior in a positive way may appreciate parental engagement and be more satisfied with the relationship with their parents. Children may also perceive parental reminders/dropping hints to break SB as strategies of the promotion of volitional functioning [14]. Importantly these positive control strategies are similar to autonomy support strategies rather than positive conditional regard strategies [14]. Previous research showed that adolescents, who perceive frequent parental use of control strategies similar to autonomy support report higher relationship satisfaction with parents [52].

Second, we observed a positive association between child-received positive control (T1) and parental relationship satisfaction (T2). Child and parental relationship satisfaction at T2 were also associated (see correlation coefficients). It is possible that the link between child receipt of positive control and parental relationship satisfaction may be mediated by child reports of relationship satisfaction, as suggested by the DHIM model [9]. As the potential mediation mechanism was not tested in our study directly, future research should consider longitudinal links between relationship satisfaction assessed in one dyadic member, and subsequent relationship satisfaction in the other member of a dyad.

Relationship Satisfaction in the Parent-Child Dyad and Parental Sedentary Behaviors

Child perceptions of higher relationship satisfaction (T2) were associated with parents spending *less time sitting* (T3). In line with DIHM [9], children's reports of satisfaction with

the relationship with their parent may reinforce parental efforts to further invest in the relationship. Child's satisfaction with the relationship may act as a trigger for a parent to explore and adopt new behaviors (e.g., actively breaking sedentary bouts), without worrying about how to improve the child's perception of relationship satisfaction, or how to avoid being perceived as manipulative due to performing new actions.

Parental perceptions of higher relationship satisfaction with their children (T2), were associated with parents spending *more time sitting* (T3). Feeling satisfied with the relationship with the child, parents may believe they do not need to invest efforts and change their behaviors (make attempts to reduce sitting). The positive association between relationship satisfaction (in parents) and a lack of parental efforts to change behaviors may be interpreted as consistent with the tenets of the prevention focus approach which assumes that people concentrate on maintaining the (satisfactory) status quo and avoid engaging in any actions, which may potentially result in undesirable outcomes, such as a reduction of relationship satisfaction [53]. In the prevention focus, parents who are satisfied with the relationship may tend to maintain the status quo, being happy with what they have, and not engaging in the reduction of SB time to avert potential negative outcomes of a change. The link between higher relationship satisfaction among parents and higher SB indicators in parents is similar to findings obtained in an earlier study enrolling adult patients and their adult partners [19].

The link between higher relationship satisfaction reported by parents and more time spent on SB by parents may be also explained by the actual content of SB. SB that involve parent and child spending time together, including activities appreciated by both parent and child (e.g., playing games together or joint problem solving while sitting), may contribute to higher relationship satisfaction. Unfortunately, our study did not assess the actual content of SB nor did we assess behavior synchronicity (sitting together by parent and child), which

limits the possibility of drawing conclusions regarding what actually happened during SB. We did not investigate whether SB activities were performed together or not, for how long, and whether they were evaluated as satisfactory by both parents and children. This is because the main focus of the original trial (and education delivered at T1) [31] was to reduce SB time, which, on average exceeded 7h (parents, T1) and 9h (children, T1) per day.

The additional analyses indicated that longer SB time (T1) in children was associated with lower relationship satisfaction reported by both children (T3) and parents (T3). We also found that child SB levels did not change between T1 and T3. The negative SB--satisfaction association may be due to the specific context of the study, namely participants' moderate-to-high intention to reduce SB and the education procedures [31] which, among others, focused on SB time reduction. In children who spent more time on SB, time and efforts invested in participating in the intervention did not result in expected behavior changes, which could be related to low satisfaction with joint efforts to change SB, and consequently a lower level of relationship satisfaction.

Besides being a predictor or a mediator of social control, relationship satisfaction may also operate as a moderator of the associations between different types of social control and health behaviors [54]. This approach was not investigated in our study, which is yet another limitation. Future research should compare the mediator and moderator models to establish which one explains health behaviors better.

Parental Provision of Social Control as a Predictor of Relationship Satisfaction and SB in Parent-Child Dyads

One variable explained accelerometer-assessed SB time among children: Parental reports of *frequent provision of positive social control* (T1) were associated with *more child SB time* (T3). Additionally, parental reports of more frequent provision of positive social control (T1) were associated with *lower relationship satisfaction* among children (T2). It is

possible that parental reports of provision of positive control referred to their use of conditional positive regard. Previous research suggested that this conditional positive regard has counterintuitive negative effects, such as children's reports of dissatisfaction with parent-child relationship and poorer behavioral outcomes [14,16]. However, research to date mostly addressed child receipt of positive conditional regard [14,16] whereas our findings deal with parental provision of positive social control. The interpretation, assuming that our assessments of parental reports of provision of positive social control study capture actions similar to positive conditional regard [14, 48, 49], is hypothetical. The measurement applied in this study was limited, and parental intention to use positive regard conditionally on child performance was not fully captured. Additionally, the association between parental provision of positive control (T1) and child SB (T3) was not replicated for the T2 indicator of parental provision of positive control (see the results of the path analysis). Consequently, the latter association may be less likely to be replicated in other contexts. Other associations found in our study also require replications, for example using multiple measurement points spanning either shorter or longer periods.

Limitations

This study has several limitations. The majority of parents were women with higher education and medium or higher economic status, which limits any generalizations. Hip-worn accelerometers are inferior to other instruments, such as ActivPal, allowing for a more precise assessment of SB. The sample size did not allow for detecting effects of other social influences or relationship variables or controlling for more self-regulatory or environmental factors. Pre- and early adolescents may differ in determinants of SB and in average time spent on SB [55] but conducting well-powered analyses investigating the moderating effects of the age group would require a sample of approximately 150 dyads more. The observed effects were small, and their impact on health requires further research. The time span between the

measurement points was chosen to account for long-term behavior change patterns (>6 months between baseline and the last follow-up of SB assessment [27]). A stronger design would include multiple measurement points during periods > 6 months, as well as similar time gaps between the assessments of the independent, mediator, and dependent variables in the model.

Conclusions

This study focused on parent-child dyads participating in an intervention to increase PA. Several variables included in our models predicted SB time. Parental reports of more frequent provision of positive social control (T1) were associated with more parent and child SB time at T3. Additionally, higher satisfaction with the relationship reported by children predicted less time spent on SB by their parents. At the same time, higher satisfaction with the relationship reported by parents predicted more time spent on SB by parents.

We found complex associations between children's receipt and parental provision of social control, relationship satisfaction among children and parents, and our main outcome SB time. Parental provision of positive control reported by parents (T1) was directly related to higher SB in both children and parents (T3). Higher levels of relationship satisfaction among parents (T1, T2), predicted higher parental SB at T3. Higher relationship satisfaction among children (T2) was related to lower parental SB at T3.

Furthermore, findings for positive social control suggest additional complexities. Results depend on whether control is provided or received. Child reports of received positive control (T1) predicted higher relationship satisfaction in children and parents (T2). At the same time, more parental provision of positive control (T1) was related with lower child relationship satisfaction (T2), indicating that different positive social control strategies might be involved in the latter two opposite effects.

Compliance with Ethical Standards

Authors' Statement of Conflict of Interest and Adherence to Ethical Standards

Conflict of interest: Authors declare that they have no conflict of interest.

Research involving human participants and/or animals All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committees and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all participants included in the study.

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Figure captions

Figure 1

Direct and Indirect Effects for the 'Social Control → Relationship Satisfaction → Sedentary Behavior Time' Mediation Model

Note. ** $p < .01$; * $p < .05$. Only significant effect coefficients are presented along solid black lines. Significant indirect effects are marked with bold lines. Grey lines represent direct effects that were not significant. T1 = Time 1, the baseline; T2 = Time 2, 8 weeks after T1; T3 = Time 3, 8 months after T1. Residuals of all predictors, mediators, and the outcome variables were assumed to covary (for clarity, covariances are not displayed). The model controlled for the baseline behavior (sedentary behavior at T1; not displayed for clarity reasons).

Figure 2

Direct and Indirect Effects for the 'Relationship Satisfaction → Social Control → Sedentary Behavior Time' Mediation Model

Note. ** $p < .01$; * $p < .05$. Only significant effect coefficients are presented along solid black lines. Grey lines represent direct effects that were not significant. T1 = Time 1, the baseline; T2 = Time 2, 8 weeks after T1; T3 = Time 3, 8 months after T1. Residuals of all predictors, mediators, and the outcome variables were assumed to covary (for clarity, covariances are not displayed). The model controlled for the baseline behavior (sedentary behavior at T1; not displayed for clarity reasons).

Table 1

Direct Effects for the 'Social Control → Relationship Satisfaction → Sedentary Behavior' Mediation Model

Variables and hypothesized associations	*B*	*SE*	*β*	*p*
Positive Received Control (CH, T1) → Relationship Satisfaction (CH, T2)	**0.335**	**0.059**	**.487**	**<.001**
Positive Received Control (CH, T1) → Relationship Satisfaction (P, T2)	**0.149**	**0.045**	**.292**	**<.001**
Positive Received Control (CH, T1) → Sedentary Behavior (CH, T3)	-0.959	6.694	-.010	.886
Positive Received Control (CH, T1) → Sedentary Behavior (P, T3)	2.887	6.184	.029	.641
Positive Provided Control (P, T1)→ Relationship Satisfaction (CH, T2)	**-0.124**	**0.061**	**-.140**	**.041**
Positive Provided Control (P, T1)→ Relationship Satisfaction (P, T2)	0.070	0.046	.106	.134
Positive Provided Control (P, T1)→ Sedentary Behavior (CH, T3)	**13.642**	**6.647**	**.115**	**.040**
Positive Provided Control (P, T1)→ Sedentary Behavior (P, T3)	**12.472**	**6.141**	**.097**	**.042**
Negative Received Control (CH, T1) → Relationship Satisfaction (CH, T2)	-0.088	0.062	-.127	.158
Negative Received Control (CH, T1) → Relationship Satisfaction (P, T2)	0.006	0.047	.011	.906
Negative Received Control (CH, T1) → Sedentary Behavior (CH, T3)	-11.274	6.658	-.122	.090
Negative Received Control (CH, T1) → Sedentary Behavior (P, T3)	-7.696	6.151	-.077	.211
Negative Provided Control (P, T1)→ Relationship Satisfaction (CH, T2)	-0.029	0.057	-.037	.605
Negative Provided Control (P, T1)→ Relationship Satisfaction (P, T2)	**-0.093**	**0.043**	**-.158**	**.032**
Negative Provided Control (P, T1)→ Sedentary Behavior (CH, T3)	-1.251	6.129	-.012	.838
Negative Provided Control (P, T1)→ Sedentary Behavior (P, T3)	1.329	5.663	.012	.814
Sedentary Behavior (CH, T1)→ Sedentary Behavior (CH, T3)	**0.413**	**0.043**	**.489**	**<.001**
Sedentary Behavior (P, T1)→ Sedentary Behavior (P, T3)	**0.499**	**0.035**	**.624**	**<.001**
Relationship Satisfaction (CH, T2) → Sedentary Behavior (CH, T3)	-7.416	7.524	-.055	.324
Relationship Satisfaction (CH, T2) → Sedentary Behavior (P, T3)	**-19.806**	**6.951**	**-.137**	**.004**
Relationship Satisfaction (P, T2) → Sedentary Behavior (CH, T3)	14.778	9.859	.081	.134
Relationship Satisfaction (P, T2) → Sedentary Behavior (P, T3)	**38.980**	**9.108**	**.200**	**<.001**

Note. T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; Significant coefficients are marked in bold.

Table 2

Direct Effect for the 'Relationship Satisfaction → Social Control→ Sedentary Behavior Time' Mediation Model

Variables and hypothesized associations	*B*	*SE*	*β*	*p*
Relationship Satisfaction (CH, T1) → Positive Received Control (CH, T2)	**0.416**	**0.091**	**.295**	**<.001**
Relationship Satisfaction (CH, T1) → Positive Provided Control (P, T2)	0.022	0.075	.020	.766
Relationship Satisfaction (CH, T1) → Negative Received Control (CH, T2)	**0.191**	**0.092**	**.141**	**.038**
Relationship Satisfaction (CH, T1) → Negative Provided Control (P, T2)	-0.034	0.077	-.031	.655
Relationship Satisfaction (CH, T1) → Sedentary Behavior (CH, T3)	-3.852	7.376	-.028	.602
Relationship Satisfaction (CH, T1) → Sedentary Behavior (P, T3)	-9.032	6.973	-.061	.195
Relationship Satisfaction (P, T1) → Positive Received Control (CH, T2)	0.212	0.118	.116	.072
Relationship Satisfaction (P, T1) → Positive Provided Control (P, T2)	0.124	0.098	.087	.203
Relationship Satisfaction (P, T1) → Negative Received Control (CH, T2)	-0.027	0.119	-.015	.820
Relationship Satisfaction (P, T1) → Negative Provided Control (P, T2)	-0.073	0.100	-.050	.464
Relationship Satisfaction (P, T1) → Sedentary Behavior (CH, T3)	4.655	9.345	.026	.618
Relationship Satisfaction (P, T1) → Sedentary Behavior (P, T3)	**19.915**	**8.835**	**.104**	**.024**
Sedentary Behavior (CH, T1) → Sedentary Behavior (CH, T3)	**0.426**	**0.043**	**.502**	**<.001**
Sedentary Behavior (P, T1) → Sedentary Behavior (P, T3)	**0.498**	**0.036**	**.629**	**<.001**
Positive Received Control (CH, T2) → Sedentary Behavior (CH, T3)	-4.766	6.788	-.049	.483
Positive Received Control (CH, T2) → Sedentary Behavior (P, T3)	-6.583	6.418	-.063	.305
Positive Provided Control (P, T2)→ Sedentary Behavior (CH, T3)	-0.534	7.008	-.004	.939
Positive Provided Control (P, T2)→ Sedentary Behavior (P, T3)	6.553	6.626	.049	.323
Negative Received Control (CH, T2) → Sedentary Behavior (CH, T3)	0.798	6.967	.008	.909
Negative Received Control (CH, T2) → Sedentary Behavior (P, T3)	3.425	6.587	.031	.603
Negative Provided Control (P, T2)→ Sedentary Behavior (CH, T3)	-6.476	7.104	-.052	.362
Negative Provided Control (P, T2)→ Sedentary Behavior (P, T3)	-0.378	6.717	-.003	.955

Note. T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; Significant coefficients are marked in bold.

Figure 1

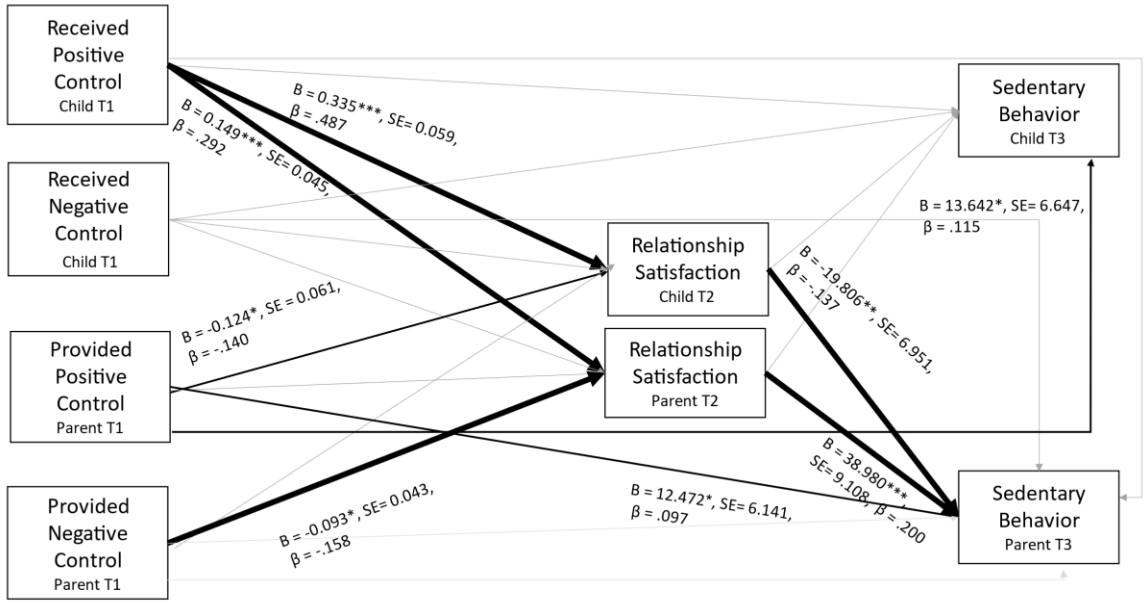
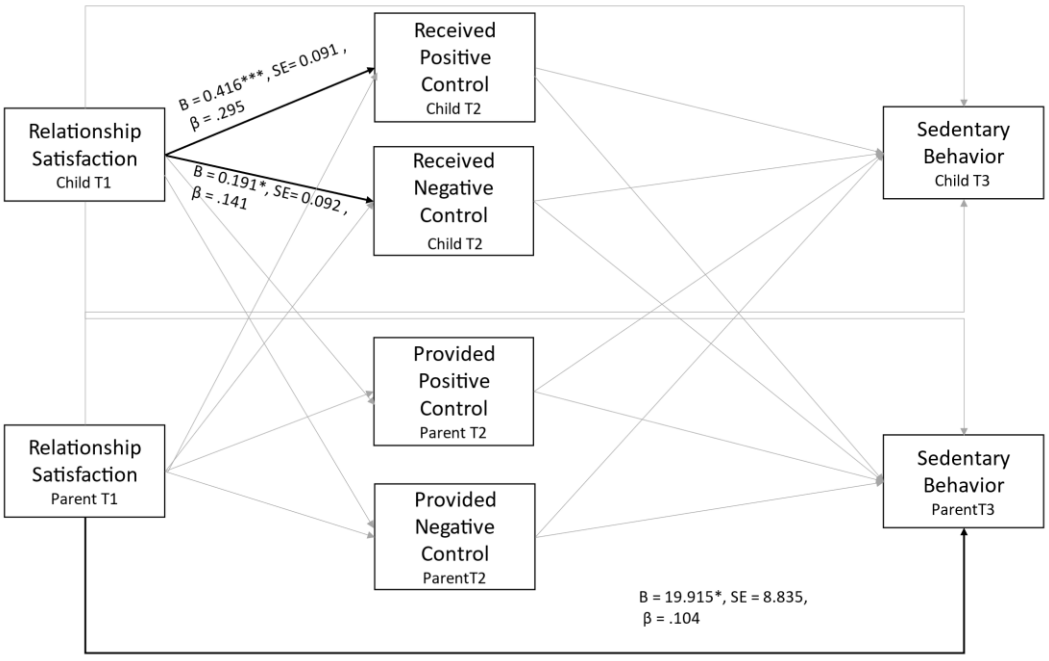


Figure 2



Positive and negative parental social control, relationship satisfaction, and sedentary behavior in parent-child dyads

Electronic Supplemental Material 1

Electronic Supplemental Material 1 includes:

- **Analytic Strategy for Bivariate Associations**
- **Results of Attrition Analysis**
- **Differences Between Parent and Child and Changes over Time in the Main Study Variables**
- **Supplementary Table 1** - Findings for the Total Sample of N = 247 Parent - Child Dyads: Descriptive Statistics, Reliability, and Correlations
- **Supplementary Table 2** - Estimates of Intraclass Correlation Coefficient for the Study Variables
- **Supplementary Table 3** - Indirect Effects for the 'Social Control → Relationship Satisfaction → SB Time' Mediation Model
- **Supplementary Table 4** - Covariances for the 'Social Control → Relationship Satisfaction → SB Time' Mediation Model
- **Supplementary Table 5** - Direct Effects for the 'Social Control → Relationship Satisfaction → SB' Model Tested with Additional Covariates
- **Supplementary Table 6** - Indirect Effects for the 'Social Control → Relationship Satisfaction → SB' Model Tested with Additional Covariates
- **Supplementary Table 7** - Covariances for the 'Social Control → Relationship Satisfaction → SB' Model Tested with Additional Covariates
- **Supplementary Table 8** - Indirect Effects for the 'Relationship Satisfaction → Social Control → SB Time' Mediation Model

- **Supplementary Table 9 -** Covariances for the ‘Relationship Satisfaction → Social Control → SB Time’ Mediation Model
- **Supplementary Table 10 -** Direct Effect for the ‘Relationship Satisfaction →Social Control → SB’ Model Tested with Additional Covariates
- **Supplementary Table 11 -** Indirect Effects for the ‘Relationship Satisfaction →Social Control → SB’ Model Tested with Additional Covariates
- **Supplementary Table 12 -** Covariances for the ‘Relationship Satisfaction →Social Control → SB’ Model Tested with Additional Covariates
- **Supplementary Table 13 -** Direct Effect for the ‘SB Time → Control → Relationship Satisfaction’ Model
- **Supplementary Table 14 -** Indirect Effects for the ‘SB Time → Control → Relationship Satisfaction’ Model
- **Supplementary Table 15 -** Covariances for the ‘SB Time → Control → Relationship Satisfaction’ Model
- **Supplementary Table 16 -** Direct Effect for the ‘SB Time → Relationship Satisfaction → Control’ Model
- **Supplementary Table 17 -** Indirect Effects for the ‘SB Time → Relationship Satisfaction → Control’ Model
- **Supplementary Table 18 -** Covariances for the ‘SB Time → Relationship Satisfaction → Control’ Model

Analytic Strategy for Bivariate Associations

Pearson *r* correlation coefficients were calculated for within-person associations (e.g., parental SB time and parental relationship satisfaction) and for cases when the same variable was calculated for both dyadic members (e.g., SB time in parent and SB time in child). Intraclass correlation coefficients were calculated for across-persons association for indicators of provided and received control (e.g., negative control provided by parent and negative control received by child) [1]. To avoid interdependency bias, the bivariate correlations were not calculated when two different variables were assessed in two members of parent-child dyads; these associations are better captured by path models [2], such as those calculated in our main analyses. Partial coefficients were calculated in case of SB indicators, calculated controlling for the accelerometer wear time.

Results of Attrition Analysis

Among children, analyses for T1 data showed no differences between completers and drop-outs in gender, χ^2 (1, N = 247) = 0.31 p = .579, age, F(1, 245) = 0.03, p = .867, relationship satisfaction, F(1, 242) = 0.02, p = .877, positive social control F(1, 221) = 0.66, p = .416, negative social control F(1, 221) = 0.80, p = .373, or T1 SB time, F(1, 232) = 0.07, p = .796.

Regarding parents, T1 data analyses showed that completers and those who dropped out did not differ in gender, χ^2 (1, N = 247) = 0.78, p = .377, age, F(1, 245) = 1.48, p = .225, economic status, F(1, 242) = 0.66, p = .416, education, F(1, 244) = 0.62, p = .431, relationship satisfaction, F(1, 244) = 0.11, p = .743, positive social control F(1, 226) = 0.74, p = .391, negative social control F(1, 226) = 0.15, p = .697, or T1 SB time, F(1, 233) = 0.00, p = .974.

Differences Between Parent and Child and Changes over Time in the Main Study Variables

On average, children and their parents reported that they intended to reduce SB at T1 (M_{CH} = 2.86, *SD* = 0.64; M_P = 2.88, *SD* = 0.67; mean item response scale range: 1-4). Intentions of parents and children were similar in strength, paired *t*(246) = 0.34, *p* = .731

There was no significant change in SB time from T1 to T3 among children, *F*(1, 246) = 0.29 *p* = .589, η^2 = .001 (the average SB time per day time in minutes, T1: M_{CH} = 538.94, *SD* = 85.91; T3: M_{CH} = 541.61, *SD* = 74.38), but there was a small reduction of SB time among parents, *F*(1, 246) = 6.26, *p* = .0.013, η^2 = .025 (the average SB time per day time at T1: M_P = 478.163, *SD* = 98.14; T3: M_P = 466.46, *SD* = 79.95; Cohen's *d* = 0.13).

On average, children and their parents reported being satisfied with their relationship (T1 mean item response on a scale ranging from 1 to 4: M_{CH} = 3.55, *SD* = 0.53; M_P = 3.67, *SD* = 0.40). Relationship satisfaction was higher in parents than in children, both at T1, paired *t*(246) = 2.50, *p* = .013, Cohen's *d* = 0.26, and at T2, paired *t*(246) = 4.08, *p* <.001, Cohen's *d* = 0.26. There was no change in relationship satisfaction between T1 and T2, neither among children *F*(1, 246) = 0.03, *p* = .864, η^2 <.001, nor their parents *F*(1, 246) = 2.34, *p* = .127, η^2 = .009.

Parents and their children did not differ in reports of negative control at T1 (M_{CH} = 2.01, *SD* = 0.79; M_P = 2.05, *SD* = 0.68), paired *t*(246) = 0.88, *p* = .382. Parents reported higher T1 positive control than their children (M_{CH} = 2.35, *SD* = 0.79; M_P = 2.73, *SD* = 0.61), paired *t*(246) = 6.98, *p* = .001, Cohen's *d* = 0.44. At T2, both members of the dyad reported similarly low levels of negative control, paired *t*(246) = 0.12, *p* = .905, but again parents reported higher levels of positive control than did their children (M_{CH} = 2.37, *SD* = 0.74; M_P = 2.69, *SD* = 0.58), paired *t*(246) = 6.11, *p* <.001, Cohen's *d* = 0.39. There was no change in reports of negative control between T1 and T2, neither among children, *F*(1, 246) = 1.73, *p* =

.190, η^2 = .007, nor parents, $F(1, 246) = 0.89$, p = .347, η^2 = .004. Comparing T1 and T2 levels, reports of positive control did not change among children, $F(1, 246) = 0.16$, p = .689, η^2 = <.001, nor among parents, $F(1, 246) = 0.88$, p = .350, η^2 = .004.

Supplementary Table 1

Findings for the Total Sample of N = 247 Parent - Child Dyads: Descriptive Statistics, Reliability, and Correlations

		M (SD)	*α*	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Relationship Satisfaction (CH, T1)	3.55 (0.52)	.854	.370**	.508**	.275**	.364**		.339**		.263**		.139*		-.018		-.002		.069		-.112	
2	Relationship Satisfaction (P, T1)	3.63 (0.40)	.745		.352**	.499**		.134*		.095		-.002		-.062		-.057		.119†		.161*		-.021
3	Relationship Satisfaction (CH, T2)	3.54 (0.54)	.864			.471**	.348**		.387**		.167**		.186**		-.093		-.060		-.007		-.104	
4	Relationship Satisfaction (P, T2)	3.67 (0.40)	.779					.117†		.163**		-.032		.027		-.021		.214**		.035		-.133*
5	Positive Received Control (CH, T1)	2.35 (0.79)	.900						.539**		.719**		.406**		-.058		-.086		-.084		-.088	
6	Positive Provided Control (P, T1)	2.73 (0.61)	.879							.423**		.490**		.252**		-.080		.179*		.082		-.001
7	Positive Received Control (CH, T2)	2.37 (0.74)	.914								.408**		.659**		-.053		-.073		-.004		-.174**	
8	Positive Provided Control (P, T2)	2.69 (0.58)	.872									.225**		.482**		-.011		.069		.052		-.072
9	Negative Received Control (CH, T1)	2.00 (0.78)	.891										.446**		-.093		-.118†		-.118		-.124	
10	Negative Provided Control (P, T1)	2.05 (0.68)	.828											.508**		-.096		.056		.036		.142*
11	Negative Received Control (CH, T2)	1.94 (0.71)	.890											.	.032		-.059		-.064		-.141*	
12	Negative Provided Control (P, T2)	2.01 (0.59)	.781													.066		.032		.100		.026
13	SB (CH, T1)	538.94 (85.91)														.347**	.514**	.045	.102		.329**	
14	SB (P, T1)	478.16 (98.14)															..087	.721**		-.129*		.154*
15	SB (CH, T3)	541.61 (74.38)																.275**	.019		.331**	
16	SB (P, T3)	466.46 (79.95)																		-.062		.156*
17	Gender CH																			.023	.008	.036
18	Gender P																				-.058	-.144*
19	Age CH	11.37 (1.23)																				.179**
20	Age P	41.00 (4.87)																				

Note. = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Partner; SB = Sedentary Behavior Time; ** $p < .01$; * $p < .05$. For each association where an SB indicator was included in the equation, the wear time for the respective measurement point was partialled out. For each association where SB at T3 was included in the equation, the SB at T1 and the wear time for both measurement points were partialled out.

Supplementary Table 2

Estimates of Intraclass Correlation Coefficient for the Study Variables

Variables	ICC value	*p*
Relationship Satisfaction (CH, T1) - Relationship Satisfaction (CH, T2)	.508	< .001
Relationship Satisfaction (P, T1) - Relationship Satisfaction (P, T2)	.498	< .001
Relationship Satisfaction (CH, T1) - Relationship Satisfaction (P, T2)	.257	< .001
Relationship Satisfaction (P, T1) - Relationship Satisfaction (CH, T2)	.333	< .001
Positive Received Control (CH, T1)- Positive Received Control (CH, T2)	.538	< .001
Positive Received Control (CH, T1)- Positive Provided Control (P, T1)	.245	< .001
Positive Received Control (CH, T1) - Positive Provided Control (P, T2)	.195	< .001
Positive Received Control (CH, T2)- Positive Provided Control (P, T2)	.207	< .001
Positive Provided Control (P, T1)- Positive Provided Control (P, T2)	.423	< .001
Positive Provided Control (P, T1) - Positive Received Control (CH, T2)	.191	< .001
Negative Received Control (CH, T1) - Negative Received Control (CH, T2)	.439	< .001
Negative Received Control (CH, T1) - Negative Provided Control (P, T1)	.405	< .001
Negative Received Control (CH, T1) - Negative Provided Control (P, T2)	.214	< .001
Negative Received Control (CH, T2) - Negative Provided Control (P, T2)	.319	< .001
Negative Provided Control (P, T1) - Negative Provided Control (P, T2)	.502	< .001
Negative Provided Control (P, T1) - Negative Received Control (CH, T2)	.317	< .001
Sedentary Behavior (CH, T1) - Sedentary Behavior (CH, T2)	.508	< .001
Sedentary Behavior (P, T1) - Sedentary Behavior (P, T2)	.638	< .001
Sedentary Behavior (CH, T1) - Sedentary Behavior (P, T2)	.177	< .001
Sedentary Behavior (P, T1) - Sedentary Behavior (Ch, T2)	.198	< .001

Note. ICC = Intraclass correlation coefficient, absolute agreement; CH = Child; P = Parent.

Supplementary Table 3
Covariances for the 'Social Control → Relationship Satisfaction → SB Time' Mediation Model

Covariances			Estimate	*SE*	*p*
Positive Received Control (CH, T1)	↔	Positive Provided Control (P, T1)	**0.138**	**0.032**	**<.001**
Positive Received Control (CH, T1)	↔	Negative Received Control (CH, T1)	**0.441**	**0.048**	**<.001**
Positive Received Control (CH, T1)	↔	Negative Provided Control (P, T1)	**0.127**	**0.035**	**<.001**
Positive Provided Control (P, T1)	↔	Negative Provided Control (P, T1)	**0.203**	**0.029**	**<.001**
Negative Received Control (CH, T1)	↔	Positive Provided Control (P, T1)	**0.148**	**0.032**	**<.001**
Negative Received Control (CH, T1)	↔	Negative Provided Control (P, T1)	**0.217**	**0.037**	**<.001**
Sedentary Behavior (CH, T1)	↔	Sedentary Behavior (P, T1)	**2931.045**	**560.479**	**<.001**
Relationship Satisfaction (CH, T2)	↔	Relationship Satisfaction (P, T2)	**0.079**	**0.013**	**<.001**
Sedentary Behavior (CH, T3)	↔	Sedentary Behavior (P, T3)	**1302.470**	**245.515**	**<.001**
Weartime (CH, T1)	↔	Sedentary Behavior (CH, T1)	**33.080**	**6.166**	**<.001**
Weartime (CH, T1)	↔	Sedentary Behavior (P, T1)	2.296	6.365	.718
Weartime (CH, T1)	↔	Sedentary Behavior (CH, T3)	-1.040	3.463	.764
Weartime (CH, T1)	↔	Weartime (P, T1)	**0.542**	**0.090**	**<.001**
Weartime (CH, T1)	↔	Weartime (CH, T3)	**0.322**	**0.064**	**<.001**
Weartime (CH, T1)	↔	Weartime (P, T3)	**0.267**	**0.070**	**<.001**
Weartime (P, T1)	↔	Sedentary Behavior (CH, T1)	**21.063**	**5.893**	**<.001**
Weartime (P, T1)	↔	Sedentary Behavior (P, T1)	**38.138**	**7.820**	**<.001**
Weartime (P, T1)	↔	Sedentary Behavior (P, T3)	-6.611	3.781	.080
Weartime (P, T1)	↔	Weartime (CH, T3)	**0.240**	**0.064**	**.001**
Weartime (P, T1)	↔	Weartime (P, T3)	**0.627**	**0.094**	**<.001**
Weartime (CH, T3)	↔	Sedentary Behavior (CH, T1)	**11.568**	**4.266**	**.007**
Weartime (CH, T3)	↔	Sedentary Behavior (CH, T3)	**29.005**	**4.096**	**<.001**
Weartime (CH, T3)	↔	Sedentary Behavior (P, T3)	**18.058**	**3.583**	**<.001**
Weartime (CH, T3)	↔	Weartime (P, T3)	**0.549**	**0.074**	**<.001**
Weartime (P, T3)	↔	Sedentary Behavior (P, T1)	3.826	5.830	.512
Weartime (P, T3)	↔	Sedentary Behavior (CH, T3)	**16.271**	**4.157**	**<.001**
Weartime (P, T3)	↔	Sedentary Behavior (P, T3)	**28.548**	**4.515**	**<.001**

Note. T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; Weartime = average number of hours of wearing the accelerometer per day; Significant coefficients are marked in bold.

Supplementary Table 4

Indirect Effects for the 'Social Control → Relationship Satisfaction → SB Time' Mediation Model

Simple indirect effects, total indirect effect, direct effect, total effect		Estimate	*SE*	95%BCI		
				Lower	Upper	*p*
Simple indirect effects	Positive Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3)	-2.483	2.432	-7.653	2.101	.262
	Positive Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3)	2.196	1.693	-0.495	6.368	.100
Direct effect	Positive Received Control (CH, T1)→ SB (CH, T3)	-0.959	7.053	-15.329	12.291	.886
Total indirect effect	Positive Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3) + Positive Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3)	-0.286	2.128	-4.557	3.750	.892
Total effect	Positive Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3) + Positive Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3) +Positive Received Control (CH, T1)→ SB (CH, T3)	-1.246	6.745	-14.743	11.646	.874
Simple indirect effects	Positive Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3)	**-6.631**	**2.720**	**-12.973**	**-2.056**	**.006**
	Positive Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3)	**5.793**	**2.297**	**2.095**	**11.319**	**.002**
Direct effect	Positive Received Control (CH, T1)→ SB (P, T3)	2.887	6.811	-10.242	16.281	.690
Total indirect effect	Positive Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3) + Positive Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3)	-0.838	2.714	-6.290	4.568	.742
Total effect	Positive Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3) + Positive Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3) + Positive Received Control (CH, T1)→ SB (P, T3)	2.049	6.692	-11.217	15.026	.796
Simple indirect effects	Positive Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3)	0.921	1.178	-0.526	4.677	.179
	Positive Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3)	1.028	1.236	-0.356	5.040	.160
Direct effect	Positive Provided Control (P, T1)→ SB (CH, T3)	13.642	7.153	-0.233	28.081	.053
Total indirect effect	Positive Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3) + Positive Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3)	1.949	1.892	-0.667	7.460	.140
Total effect	Positive Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3) + Positive Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3) + Positive Provided Control (P, T1)→ SB (CH, T3)	**15.591**	**6.992**	**1.778**	**30.099**	**.026**
Simple indirect effects	Positive Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3)	2.460	1.882	0.000	7.540	.050
	Positive Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3)	2.711	2.414	-0.909	8.721	.152
Direct effect	Positive Provided Control (P, T1)→ SB (P, T3)	**12.472**	**5.960**	**0.738**	**24.128**	**.037**
Total indirect effect	Positive Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3) + Positive Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3)	**5.171**	**3.017**	**0.618**	**12.462**	**.023**
Total effect	Positive Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3) + Positive Provided Control (P, T1)→	**17.642**	**6.446**	**4.937**	**30.099**	**.006**

	Relationship Satisfaction (P, T2) → SB (P, T3) + Positive Provided Control (P, T1)→ SB (P, T3)					
Simple indirect effects	Negative Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3)	0.649	0.760	-0.317	3.033	.151
	Negative Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3)	0.083	0.699	-1.129	1.885	.739
Direct effect	Negative Received Control (CH, T1)→ SB (CH, T3)	-11.274	7.718	-26.203	3.993	.148
Total indirect effect	Negative Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3) + Negative Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3)	0.732	0.964	-0.709	3.461	.257
Total effect	Negative Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3) + Negative Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3) + Negative Received Control (CH, T1)→ SB (CH, T3)	-10.543	7.609	-25.185	4.635	.171
Simple indirect effects	Negative Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3)	1.734	1.294	-0.046	5.333	.057
	Negative Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3)	0.218	1.597	-3.147	3.315	.869
Direct effect	Negative Received Control (CH, T1)→ SB (P, T3)	-7.696	7.347	-22.447	6.515	.288
Total indirect effect	Negative Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3) + Negative Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3)	1.952	1.606	-0.947	5.570	.161
Total effect	Negative Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3) + Negative Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3) + Negative Received Control (CH, T1)→ SB (P, T3)	-5.744	7.520	-20.878	8.712	.444
Simple indirect effects	Negative Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3)	0.218	0.692	-0.455	2.659	.425
	Negative Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3)	-1.376	1.219	-4.875	0.194	.093
Direct effect	Negative Provided Control (P, T1)→ SB (CH, T3)	-1.251	6.481	-14.484	11.074	.850
Total indirect effect	Negative Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3) + Negative Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3)	-1.158	1.103	-4.376	0.395	.133
Total effect	Negative Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3) + Negative Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3) + Negative Provided Control (P, T1)→ SB (CH, T3)	-2.410	6.398	-15.675	9.552	.678
Simple indirect effects	Negative Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3)	0.582	1.276	-1.464	3.815	.489
	Negative Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3)	**-3.630**	**2.069**	**-8.646**	**-0.358**	**.026**
Direct effect	Negative Provided Control (P, T1)→ SB (P, T3)	1.329	5.589	-10.411	12.224	.828
Total indirect effect	Negative Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (P T3) + Negative Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (P, T2)	**-3.048**	**1.799**	**-7.491**	**-0.148**	**.040**
Total effect	Negative Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T2) + Negative Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (P, T2) + Negative Provided Control (P, T1)→ SB (P, T3)	-1.719	5.723	-13.400	9.228	.733

Note. Values of indirect effect estimates presented in bold are significant at $p < .05$; Each bootstrap was based on 10,000 repetitions; BCI = Bias-corrected confidence intervals; BCI that do not include zero indicate a significant indirect effect; T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; SB = Sedentary Behavior Time.

Supplementary Table 5

Direct Effects for the 'Social Control → Relationship Satisfaction → SB' Model Tested with Additional Covariates

Variables and hypothesized associations	**B**	***SE***	***β***	***p***
Positive Received Control (CH, T1) → Relationship Satisfaction (CH, T2)	**0.332**	**0.059**	**.481**	**<.001**
Positive Received Control (CH, T1)→ Relationship Satisfaction (P, T2)	**0.147**	**0.045**	**.288**	**.001**
Positive Received Control (CH, T1)→ Sedentary Behavior (CH, T3)	-0.641	6.655	-.007	.923
Positive Received Control (CH, T1)→ Sedentary Behavior (P, T3)	2.536	6.152	.025	.680
Positive Provided Control (P, T1)→ Relationship Satisfaction (CH, T2)	**-0.126**	**0.061**	**.-141**	**.038**
Positive Provided Control (P, T1)→ Relationship Satisfaction (P, T2)	0.070	0.046	.106	.134
Positive Provided Control (P, T1)→ Sedentary Behavior (CH, T3)	**13.705**	**6.620**	**.117**	**.038**
Positive Provided Control (P, T1)→ Sedentary Behavior (P, T3)	**12.855**	**6.135**	**.100**	**.036**
Negative Received Control (CH, T1) → Relationship Satisfaction (CH, T2)	-0.083	0.062	-.120	.178
Negative Received Control (CH, T1)→ Relationship Satisfaction (P, T2)	0.009	0.047	.017	.855
Negative Received Control (CH, T1)→ Sedentary Behavior (CH, T3)	-10.972	6.604	-.120	.097
Negative Received Control (CH, T1)→ Sedentary Behavior (P, T3)	-7.709	6.112	-.077	.207
Negative Provided Control (P, T1)→ Relationship Satisfaction (CH, T2)	-0.032	0.057	-.040	.576
Negative Provided Control (P, T1)→ Relationship Satisfaction (P, T2)	**-0.094**	**0.043**	**-.160**	**.029**
Negative Provided Control (P, T1)→ Sedentary Behavior (CH, T3)	-1.776	6.100	-.017	.771
Negative Provided Control (P, T1)→ Sedentary Behavior (P, T3)	1.455	5.649	.013	.797
Sedentary Behavior (CH, T1)→ Sedentary Behavior (CH, T3)	**0.399**	**0.042**	**.471**	**<.001**
Sedentary Behavior (P, T1)→ Sedentary Behavior (P, T3)	**0.504**	**0.035**	**.624**	**<.001**
Relationship Satisfaction (CH, T2) → Sedentary Behavior (CH, T3)	-7.745	7.501	-.059	.302
Relationship Satisfaction (CH, T2) → Sedentary Behavior (P, T3)	**-20.280**	**6.932**	**-.140**	**.003**
Relationship Satisfaction (P, T2) → Sedentary Behavior (CH, T3)	13.900	9.833	.078	.157
Relationship Satisfaction (P, T2) → Sedentary Behavior (P, T3)	**39.191**	**9.102**	**.200**	**<.001**

Note. T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; Significant coefficients are marked in bold; Model Fit: $\chi^2(130) = 161.864$, $p = .030$, $\chi^2/df = 1.245$, NFI = .892, CFI = .975, RMSEA = .032 (90% CI: .010, .046); Additional Covariates are: Age, Gender, Parent's Education, Parent's Economic Status, Intention to Reduce SB and Experimental Group Assignment.

Supplementary Table 6

Indirect Effects for the 'Social Control → Relationship Satisfaction → SB' Model Tested with Additional Covariates

Simple indirect effects, total indirect effect, direct effect, total effect		Estimate	SE	95%BCI		
				Lower	Upper	*p*
Simple indirect effects	Positive Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3)	-2.574	2.395	-7.743	1.890	.237
	Positive Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3)	2.040	1.643	-0.582	6.107	.114
Direct effect	Positive Received Control (CH, T1)→ SB (CH, T3)	-0.641	7.154	-15.063	13.049	.942
Total indirect effect	Positive Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3) + Positive Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3)	-0.534	2.098	-4.826	3.424	.780
Total effect	Positive Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3) + Positive Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3) +Positive Received Control (CH, T1)→ SB (CH, T3)	-1.175	6.858	-14.741	12.176	.894
Simple indirect effects	Positive Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3)	**-6.741**	**2.767**	**- 13.231**	**-2.111**	**.005**
	Positive Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3)	**5.753**	**2.328**	**2.028**	**11.379**	**.002**
Direct effect	Positive Received Control (CH, T1)→ SB (P, T3)	2.536	6.930	-10.683	16.322	.735
Total indirect effect	Positive Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3) + Positive Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3)	-0.989	2.733	-6.590	4.347	.697
Total effect	Positive Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3) + Positive Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3) + Positive Received Control (CH, T1)→ SB (P, T3)	1.548	6.800	-11.836	14.840	.853
Simple indirect effects	Positive Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3)	0.973	1.188	-0.463	4.808	.167
	Positive Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3)	0.966	1.192	-0.331	4.875	.164
Direct effect	Positive Provided Control (P, T1)→ SB (CH, T3)	13.705	7.373	-0.606	28.548	.062
Total indirect effect	Positive Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3) + Positive Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3)	1.939	1.865	-0.606	7.427	.133
Total effect	Positive Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3) + Positive Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3) + Positive Provided Control (P, T1)→ SB (CH, T3)	**15.644**	**7.178**	**1.566**	**29.856**	**.027**
Simple indirect effects	Positive Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3)	**2.548**	**1.912**	**0.075**	**7.825**	**.041**
	Positive Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3)	2.725	2.429	-0.912	8.838	.152
Direct effect	Positive Provided Control (P, T1)→ SB (P, T3)	**12.855**	**6.094**	**0.896**	**24.784**	**.036**
Total indirect effect	Positive Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3) + Positive Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3)	**5.273**	**3.038**	**0.677**	**12.588**	**.020**
Total effect	Positive Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3) + Positive Provided Control (P, T1)→	**18.128**	**6.577**	**5.163**	**30.756**	**.005**

	Relationship Satisfaction (P, T2) → SB (P, T3) + Positive Provided Control (P, T1)→ SB (P, T3)					
Simple indirect effects	Negative Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3)	0.643	0.741	-0.269	3.040	.147
	Negative Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3)	0.119	0.687	-0.958	2.041	.625
Direct effect	Negative Received Control (CH, T1)→ SB (CH, T3)	-10.972	7.766	-25.771	4.495	.161
Total indirect effect	Negative Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3) + Negative Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3)	0.762	0.941	-0.573	3.507	.222
Total effect	Negative Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3) + Negative Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3) + Negative Received Control (CH, T1)→ SB (CH, T3)	-10.211	7.665	-24.806	4.908	.185
Simple indirect effects	Negative Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3)	1.683	1.298	-0.110	5.330	.064
	Negative Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3)	0.336	1.645	-3.026	3.658	.788
Direct effect	Negative Received Control (CH, T1)→ SB (P, T3)	-7.709	7.548	-22.696	6.952	.301
Total indirect effect	Negative Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3) + Negative Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3)	2.019	1.657	-0.907	5.798	.153
Total effect	Negative Received Control (CH, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3) + Negative Received Control (CH, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3) + Negative Received Control (CH, T1)→ SB (P, T3)	-5.691	7.748	-21.049	9.356	.463
Simple indirect effects	Negative Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3)	0.245	0.706	-0.449	2.732	.400
	Negative Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3)	-1.310	1.197	-4.821	0.208	.101
Direct effect	Negative Provided Control (P, T1)→ SB (CH, T3)	-1.776	6.522	-15.291	10.494	.765
Total indirect effect	Negative Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3) + Negative Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3)	-1.065	1.086	-4.244	0.466	.151
Total effect	Negative Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (CH, T3) + Negative Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (CH, T3) + Negative Provided Control (P, T1)→ SB (CH, T3)	-2.841	6.422	-16.331	9.172	.611
Simple indirect effects	Negative Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T3)	0.641	1.299	-1.431	3.959	.461
	Negative Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (P, T3)	**-3.692**	**2.109**	**-8.962**	**-0.382**	**.026**
Direct effect	Negative Provided Control (P, T1)→ SB (P, T3)	1.455	5.816	-10.536	12.494	.830
Total indirect effect	Negative Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (P T3) + Negative Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (P, T2)	**-3.052**	**1.833**	**-7.664**	**-0.106**	**.042**
Total effect	Negative Provided Control (P, T1)→ Relationship Satisfaction (CH, T2) → SB (P, T2) + Negative Provided Control (P, T1)→ Relationship Satisfaction (P, T2) → SB (P, T2) + Negative Provided Control (P, T1)→ SB (P, T3)	-1.597	5.814	-13.520	9.639	.742

Note. Values of indirect effect estimates presented in bold are significant at $p < .05$; Each bootstrap was based on 10,000 repetitions; BCI = Bias-corrected confidence intervals; BCI that do not include zero indicate a significant indirect effect; T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; SB = Sedentary Behavior Time; Model Fit: $\chi^2(130) = 161.864$, $p = .030$, $\chi^2/df = 1.245$, NFI = .892, CFI = .975, RMSEA = .032 (90% CI: .010, .046); Additional Covariates are: Age, Gender, Parent's Education, Parent's Economic Status, Intention to Reduce SB and Experimental Group Assignment.

Supplementary Table 7

Covariances for the 'Social Control → Relationship Satisfaction → SB' Model Tested with Additional Covariates

	Covariances		Estimate	*SE*	*p*
Positive Received Control (CH, T1)	↔	Negative Received Control (CH, T1)	**0.439**	**0.048**	**<.001**
Positive Received Control (CH, T1)	↔	Positive Provided Control (P, T1)	**0.131**	**0.031**	**<.001**
Positive Received Control (CH, T1)	↔	Negative Provided Control (P, T1)	**0.122**	**0.034**	**<.001**
Positive Provided Control (P, T1)	↔	Negative Provided Control (P, T1)	**0.203**	**0.029**	**<.001**
Negative Received Control (CH, T1)	↔	Positive Provided Control (P, T1)	**0.146**	**0.031**	**<.001**
Negative Received Control (CH, T1)	↔	Negative Provided Control (P, T1)	**0.214**	**0.036**	**<.001**
Relationship Satisfaction (CH, T2)	↔	Relationship Satisfaction (P, T2)	**0.079**	**0.013**	**<.001**
Gender (CH)	↔	Positive Received Control (CH, T1)	-0.037	0.024	.127
Gender (CH)	↔	Positive Provided Control (P, T1)	**-0.055**	**0.019**	**.004**
Gender (CH)	↔	Negative Received Control (CH, T1)	**-0.049**	**0.024**	**.045**
Gender (CH)	↔	Negative Provided Control (P, T1)	-0.038	0.021	.072
Gender (CH)	↔	Relationship Satisfaction (CH, T2)	-0.004	0.015	.814
Gender (CH)	↔	Relationship Satisfaction (P, T2)	0.005	0.012	.645
Gender (CH)	↔	Gender (P)	0.004	0.011	.694
Gender (CH)	↔	Sedentary Behavior (CH, T1)	3.638	2.331	.119
Gender (CH)	↔	Sedentary Behavior (P, T1)	1.501	2.694	.577
Gender (P)	↔	Positive Received Control (CH, T1)	-0.006	0.017	.715
Gender (P)	↔	Positive Provided Control (P, T1)	0.012	0.013	.350
Gender (P)	↔	Negative Received Control (CH, T1)	0.023	0.017	.181
Gender (P)	↔	Negative Provided Control (P, T1)	0.009	0.015	.533
Gender (P)	↔	Relationship Satisfaction (CH, T2)	0.006	0.011	.561
Gender (P)	↔	Relationship Satisfaction (P, T2)	0.003	0.008	.680
Gender (P)	↔	Sedentary Behavior (CH, T1)	0.065	1.632	.968
Gender (P)	↔	Sedentary Behavior (P, T1)	**-3.760**	**1.902**	**.048**
Age (CH)	↔	Positive Received Control (CH, T1)	-0.082	0.058	.156
Age (CH)	↔	Positive Provided Control (P, T1)	-0.040	0.044	.373
Age (CH)	↔	Negative Received Control (CH, T1)	-0.111	0.057	.053
Age (CH)	↔	Negative Provided Control (P, T1)	0.028	0.050	.580
Age (CH)	↔	Relationship Satisfaction (CH, T2)	-0.045	0.036	.218
Age (CH)	↔	Relationship Satisfaction (P, T2)	-0.048	0.028	.085
Age (CH)	↔	Age (P)	**1.041**	**0.382**	**.006**
Age (CH)	↔	Sedentary Behavior (CH, T1)	**26.793**	**6.229**	**<.001**
Age (CH)	↔	Sedentary Behavior (P, T1)	9.696	6.526	.137
Age (P)	↔	Positive Received Control (CH, T1)	-0.170	0.231	.460
Age (P)	↔	Positive Provided Control (P, T1)	-0.016	0.178	.928
Age (P)	↔	Negative Received Control (CH, T1)	-0.037	0.229	.870
Age (P)	↔	Negative Provided Control (P, T1)	**0.507**	**0.204**	**.013**
Age (P)	↔	Relationship Satisfaction (CH, T2)	-0.051	0.145	.724
Age (P)	↔	Relationship Satisfaction (P, T2)	-0.181	0.112	.106
Age (P)	↔	Sedentary Behavior (CH, T1)	91.824	24.346	<.001

Age (P)	↔	Sedentary Behavior (P, T1)	48.811	26.061	.061
Education (P)	↔	Positive Received Control (CH, T1)	-0.008	0.067	.909
Education (P)	↔	Positive Provided Control (P, T1)	0.019	0.052	.715
Education (P)	↔	Negative Received Control (CH, T1)	-0.059	0.067	.382
Education (P)	↔	Negative Provided Control (P, T1)	**-0.123**	**0.059**	**.038**
Education (P)	↔	Relationship Satisfaction (CH, T2)	0.015	0.043	.717
Education (P)	↔	Relationship Satisfaction (P, T2)	-0.003	0.032	.924
Education (P)	↔	Sedentary Behavior (CH, T1)	-2.518	6.628	.704
Education (P)	↔	Sedentary Behavior (P, T1)	**34.075**	**8.325**	**<.001**
Economic Situation (P)	↔	Positive Received Control (CH, T1)	-0.032	0.042	.445
Economic Situation (P)	↔	Positive Provided Control (P, T1)	0.029	0.032	.367
Economic Situation (P)	↔	Negative Received Control (CH, T1)	-0.074	0.042	.074
Economic Situation (P)	↔	Negative Provided Control (P, T1)	0.014	0.036	.694
Economic Situation (P)	↔	Relationship Satisfaction (CH, T2)	-0.042	0.027	.112
Economic Situation (P)	↔	Relationship Satisfaction (P, T2)	-0.012	0.020	.539
Economic Situation (P)	↔	Education (P)	**-0.222**	**0.080**	**.006**
Economic Situation (P)	↔	Sedentary Behavior (CH, T1)	-4.814	4.008	.230
Economic Situation (P)	↔	Sedentary Behavior (P, T1)	**-12.210**	**4.878**	**.012**
Intention SB (CH, T1)	↔	Positive Received Control (CH, T1)	**0.083**	**0.030**	**.006**
Intention SB (CH, T1)	↔	Negative Received Control (CH, T1)	**0.066**	**0.028**	**.019**
Intention SB (CH, T1)	↔	Relationship Satisfaction (CH, T2)	0.017	0.018	.324
Intention SB (CH, T1)	↔	Intention SB (P, T1)	**0.061**	**0.026**	**.020**
Intention SB (P, T1)	↔	Positive Provided Control (P, T1)	**0.052**	**0.024**	**.030**
Intention SB (P, T1)	↔	Negative Provided Control (P, T1)	-0.010	0.025	.698
Intention SB (P, T1)	↔	Relationship Satisfaction (P, T2)	0.009	0.014	.539
Sedentary Behavior (P, T1)	↔	Sedentary Behavior (CH, T1)	**2779.008**	**536.222**	**<.001**
Sedentary Behavior (CH, T3)	↔	Gender (CH)	-1.786	1.590	.261
Sedentary Behavior (CH, T3)	↔	Gender (P)	**-2.411**	**1.124**	**.032**
Sedentary Behavior (CH, T3)	↔	Age (CH)	**13.607**	**3.959**	**<.001**
Sedentary Behavior (CH, T3)	↔	Age (P)	**39.872**	**15.563**	**.010**
Sedentary Behavior (CH, T3)	↔	Education (P)	8.579	4.470	.055
Sedentary Behavior (CH, T3)	↔	Economic Situation (P)	2.152	2.721	.429
Sedentary Behavior (CH, T3)	↔	Intention SB (CH, T1)	0.378	1.919	.844
Sedentary Behavior (CH, T3)	↔	Condition	-3.908	3.625	.281
Sedentary Behavior (CH, T3)	↔	Sedentary Behavior (P, T3)	**1296.311**	**239.404**	**<.001**
Sedentary Behavior (P, T3)	↔	Gender (CH)	-0.208	1.497	.890
Sedentary Behavior (P, T3)	↔	Gender (P)	0.188	1.052	.858
Sedentary Behavior (P, T3)	↔	Age (CH)	2.822	3.573	.430
Sedentary Behavior (P, T3)	↔	Age (P)	19.930	14.271	.163
Sedentary Behavior (P, T3)	↔	Education (P)	**13.641**	**4.374**	**.002**
Sedentary Behavior (P, T3)	↔	Economic Situation (P)	-2.906	2.628	.269
Sedentary Behavior (P, T3)	↔	Intention SB (P, T1)	2.042	1.924	.288
Sedentary Behavior (P, T3)	↔	Condition	2.043	3.464	.555
Weartime (CH, T1)	↔	Sedentary Behavior (CH, T1)	**30.415**	**5.691**	**<.001**
Weartime (CH, T1)	↔	Sedentary Behavior (P, T1)	4.650	5.983	.437
Weartime (CH, T1)	↔	Sedentary Behavior (CH, T3)	-1.962	3.374	.561
Weartime (CH, T1)	↔	Weartime (P, T1)	**0.553**	**0.091**	**<.001**
Weartime (CH, T1)	↔	Weartime (CH, T3)	**0.326**	**0.065**	**<.001**

Weartime (CH, T1)	↔	Weartime (P, T3)	**0.277**	**0.070**	**<.001**
Weartime (P, T1)	↔	Sedentary Behavior (CH, T1)	**17.275**	**5.390**	**.001**
Weartime (P, T1)	↔	Sedentary Behavior (P, T1)	**38.343**	**7.400**	**<.001**
Weartime (P, T1)	↔	Sedentary Behavior (P, T3)	**-8.024**	**3.736**	**.032**
Weartime (P, T1)	↔	Weartime (CH, T3)	**0.243**	**0.063**	**<.001**
Weartime (P, T1)	↔	Weartime (P, T3)	**0.636**	**0.094**	**<.001**
Weartime (CH, T3)	↔	Sedentary Behavior (CH, T1)	**9.110**	**3.951**	**.021**
Weartime (CH, T3)	↔	Sedentary Behavior (CH, T3)	**28.375**	**3.951**	**<.001**
Weartime (CH, T3)	↔	Sedentary Behavior (P, T3)	**17.975**	**3.528**	**<.001**
Weartime (CH, T3)	↔	Weartime (P, T3)	**0.555**	**0.074**	**<.001**
Weartime (P, T3)	↔	Sedentary Behavior (P, T1)	5.532	5.496	.314
Weartime (P, T3)	↔	Sedentary Behavior (CH, T3)	**16.074**	**3.964**	**<.001**
Weartime (P, T3)	↔	Sedentary Behavior (P, T3)	**27.605**	**4.414**	**<.001**

Note. T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; SB = Sedentary Behavior Time; Intention SB = Intention to change sedentary behavior at T1; Condition = the experimental condition (participating in a planning intervention) = 1, control (education) group = 0; Weartime = average number of hours of wearing the accelerometer per day; Significant coefficients are marked in bold; Model Fit: $\chi^2(130) = 161.864$, $p = .030$, $\chi^2/df = 1.245$, NFI = .892, CFI = .975, RMSEA = .032 (90% CI: .010, .046); Additional Covariates are: Age, Gender, Parent's Education, Parent's Economic Status, Intention to Reduce SB and Experimental Group Assignment.

Supplementary Table 8

Covariances for the 'Relationship Satisfaction → Social Control → SB Time' Mediation Model

	Covariances		Estimate	*SE*	*p*
Satisfaction Relationship (CH, T1)	←→	Satisfaction Relationship (P, T1)	**0.079**	**0.014**	**<.001**
Sedentary Behavior (CH, T1)	←→	Sedentary Behavior (P, T1)	**2920.204**	**560.389**	**<.001**
Positive Received Control (CH, T2)	←→	Positive Provided Control (P, T2)	**0.091**	**0.026**	**<.001**
Positive Received Control (CH, T2)	←→	Negative Received Control (CH, T2)	**0.323**	**0.037**	**<.001**
Positive Received Control (CH, T2)	←→	Negative Provided Control (P, T2)	**0.052**	**0.026**	**.045**
Positive Provided Control (P, T2)	←→	Negative Provided Control (P, T2)	**0.166**	**0.024**	**<.001**
Negative Received Control (CH, T2)	←→	Positive Provided Control (P, T2)	**0.098**	**0.026**	**<.001**
Negative Received Control (CH, T2)	←→	Negative Provided Control (P, T2)	**0.138**	**0.028**	**<.001**
Sedentary Behavior (CH, T3)	←→	Sedentary Behavior (P, T3)	**1374.255**	**253.076**	**<.001**
Weartime (CH, T1)	←→	Sedentary Behavior (CH, T1)	**33.318**	**6.188**	**<.001**
Weartime (CH, T1)	←→	Sedentary Behavior (P, T1)	2.243	6.385	.725
Weartime (CH, T1)	←→	Sedentary Behavior (CH, T3)	-1.523	3.484	.662
Weartime (CH, T1)	←→	Weartime (P, T1)	**0.549**	**0.091**	**<.001**
Weartime (CH, T1)	←→	Weartime (CH, T3)	**0.316**	**0.065**	**<.001**
Weartime (CH, T1)	←→	Weartime (P, T3)	**0.259**	**0.070**	**<.001**
Weartime (P, T1)	←→	Sedentary Behavior (CH, T1)	**21.751**	**5.970**	**<.001**
Weartime (P, T1)	←→	Sedentary Behavior (P, T1)	**38.178**	**7.835**	**<.001**
Weartime (P, T1)	←→	Sedentary Behavior (P, T3)	-5.642	3.818	.139
Weartime (P, T1)	←→	Weartime (CH, T3)	**0.238**	**0.064**	**.001**
Weartime (P, T1)	←→	Weartime (P, T3)	**0.626**	**0.094**	**<.001**
Weartime (CH, T3)	←→	Sedentary Behavior (CH, T1)	**11.261**	**4.269**	**.008**
Weartime (CH, T3)	←→	Sedentary Behavior (CH, T3)	**28.505**	**4.113**	**<.001**
Weartime (CH, T3)	←→	Sedentary Behavior (P, T3)	**17.412**	**3.621**	**<.001**
Weartime (CH, T3)	←→	Weartime (P, T3)	**0.545**	**0.074**	**<.001**
Weartime (P, T3)	←→	Sedentary Behavior (P, T1)	4.274	5.837	.464
Weartime (P, T3)	←→	Sedentary Behavior (CH, T3)	**14.911**	**4.174**	**<.001**
Weartime (P, T3)	←→	Sedentary Behavior (P, T3)	**27.514**	**4.545**	**<.001**

Note. T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; Weartime = average number of hours of wearing the accelerometer per day; Significant coefficients are marked in bold.

Supplementary Table 9

Indirect Effects for the 'Relationship Satisfaction→ Social Control→ SB Time' Mediation Model

Simple indirect effects, total indirect effect, direct effect, total effect		**Estimate**	***SE***	**95%BCI**		***p***
				Lower	**Upper**	
Simple indirect effects	Relationship Satisfaction (CH, T1)→ Positive Received Control (CH, T2)→ SB (CH, T3)	-1.984	3.324	-10.191	3.557	.424
	Relationship Satisfaction (CH, T1) → Positive Provided Control (P, T2)→ SB (CH, T3)	-0.012	0.675	-1.712	1.201	.859
	Relationship Satisfaction (CH, T1)→ Negative Received Control (CH, T2)→ SB (CH, T3)	0.152	1.789	-2.866	4.944	.800
	Relationship Satisfaction (CH, T1)→ Negative Provided Control (P, T2)→ SB (CH, T3)	0.222	0.780	- 0.533	3.539	.369
Direct effect	Relationship Satisfaction (CH, T1) → SB (CH, T3)	-3.852	6.502	-16.734	9.328	.561
Total indirect effect	Relationship Satisfaction (CH, T1)→ Positive Received Control (CH, T2)→ SB (CH, T3) + Relationship Satisfaction (CH, T1)→ Positive Provided Control (P, T2)→ SB (CH, T3) + Relationship Satisfaction (CH, T1) → Negative Received Control (CH, T2)→ SB (CH, T3) + Relationship Satisfaction (CH, T1) → Negative Provided Control (P, T2)→ SB (CH, T3)	-1.634	2.853	-8.084	3.499	.478
Total effect	Relationship Satisfaction (CH, T1) → Positive Received Control (CH, T2)→ SB (CH, T3) + Relationship Satisfaction (CH, T1) → Positive Provided Control (P, T2)→ SB (CH, T3) + Relationship Satisfaction (CH, T1) → Negative Received Control (CH, T2)→ SB (CH, T3) + Relationship Satisfaction (CH, T1) → Negative Provided Control (P, T2)→ SB (CH, T3) + Relationship Satisfaction (CH, T1) → SB (CH, T3)	-5.474	6.162	-17.949	6.491	.354
Simple indirect effects	Relationship Satisfaction (CH, T1) → Positive Received Control (CH, T2)→ SB (P, T3)	-2.741	3.201	-10.104	2.819	.298
	Relationship Satisfaction (CH, T1) → Positive Provided Control (P, T2)→ SB (P, T3)	0.146	0.757	-0.739	2.874	.539
	Relationship Satisfaction (CH, T1)→ Negative Received Control (CH, T2)→ SB (P, T3)	0.653	1.619	-1.936	4.485	.405
	Relationship Satisfaction (CH, T1)→ Negative Provided Control (P, T2 → SB (P, T3)	0.013	0.557	-0.978	1.454	.825
Direct effect	Relationship Satisfaction (CH, T1) → SB (P, T3)	-9.032	8.063	-25.411	6.038	.240
Total indirect effect	Relationship Satisfaction (CH, T1) → Positive Received Control (CH, T2)→ SB (P, T3) + Relationship Satisfaction (CH, T1) → Positive Provided Control (P, T2)→ SB (P, T3) + Relationship Satisfaction (CH, T1) → Negative Received Control (CH, T2)→ SB (P, T3) + Relationship Satisfaction (CH, T1) → Negative Provided Control (P, T2) → SB (P, T3)	-1.929	2.598	-7.731	2.606	.410
Total effect	Relationship Satisfaction (CH, T1) → Positive Received Control (CH, T2)→ SB (P, T3) + Relationship Satisfaction (CH, T1) → Positive Provided Control (P, T2)→ SB (P, T3) + Relationship Satisfaction (CH, T1) → Negative Received Control (CH, T2)→ SB (P, T3) + Relationship Satisfaction (CH, T1) → Negative Provided Control (P, T2)→ SB (P, T3) + Relationship Satisfaction (CH, T1) → SB (P, T3)	-10.961	7.423	-26.044	3.035	.128
Simple indirect effects	Relationship Satisfaction (P, T1) → Positive Received Control (CH, T2) → SB (CH, T3)	-1.012	1.858	-6.684	1.387	.317
	Relationship Satisfaction (P, T1) → Positive Provided Control (P, T2) → SB (CH, T3)	-0.066	1.469	-3.622	2.650	.809
	Relationship Satisfaction (P, T1)→ Negative Received Control (CH, T2) → SB (CH, T3)	-0.022	0.903	-2.449	1.612	.834
	Relationship Satisfaction (P, T1)→ Negative Provided Control (P, T2) → SB (CH, T3)	0.473	1.134	-0.678	4.922	.318

Direct effect	Relationship Satisfaction (P, T1) → SB (CH, T3)	4.655	9.851	-15.343	23.616	.642
Total indirect effect	Relationship Satisfaction (P, T1) → Positive Received Control (CH, T2)→ SB (CH, T3) + Relationship Satisfaction (P, T1) → Positive Provided Control (P, T2)→ SB (CH, T3) + Relationship Satisfaction (P, T1) → Negative Received Control (CH, T2)→ SB (CH, T3) + Relationship Satisfaction (P, T1) → Negative Provided Control (P, T2)→ SB (CH, T3)	-0.627	2.607	-6.147	4.371	.756
Total effect	Relationship Satisfaction (P, T1) → Positive Received Control (CH, T2)→ SB (CH, T3) + Relationship Satisfaction (P, T1) → Positive Provided Control (P, T2)→ SB (CH, T3) + Relationship Satisfaction (P, T1) → Negative Received Control (CH, T2)→ SB (CH, T3) + Relationship Satisfaction (P, T1) → Negative Provided Control (P, T2)→ SB (CH, T3) + Relationship Satisfaction (P, T1) → SB (CH, T3)	4.028	9.685	-15.221	22.979	.666
Simple indirect effects	Relationship Satisfaction (P, T1) → Positive Received Control (CH, T2)→ SB (P, T3)	-1.398	1.792	-6.542	0.995	.211
	Relationship Satisfaction (P, T1) → Positive Provided Control (P, T2)→ SB (P, T3)	0.816	1.629	-0.653	6.852	.290
	Relationship Satisfaction (P, T1)→ Negative Received Control (CH, T2)→ SB (P, T3)	-0.093	0.927	-2.951	1.137	.554
	Relationship Satisfaction (P, T1)→ Negative Provided Control (P, T2)→ SB (P, T3)	0.028	0.880	-1.523	2.393	.815
Direct effect	Relationship Satisfaction (P, T1) → SB (P, T3)	**19.915**	**9.644**	**1.274**	**39.061**	**.038**
Total indirect effect	Relationship Satisfaction (P, T1) → Positive Received Control (CH, T2)→ SB (P, T3) + Relationship Satisfaction (P, T1) → Positive Provided Control (P, T2)→ SB (P, T3) + Relationship Satisfaction (P, T1) → Negative Received Control (CH, T2)→ SB (P T3) + Relationship Satisfaction (P, T1) → Negative Provided Control (P, T2)→ SB (P, T2)	-0.648	2.380	-5.318	4.013	.662
Total effect	Relationship Satisfaction (P, T1) → Positive Received Control (CH, T2)→ SB (P, T3) + Relationship Satisfaction (P, T1) → Positive Provided Control (P, T2)→ SB (P, T3) + Relationship Satisfaction (P, T1) → Negative Received Control (CH, T2)→ SB (P, T2) + Relationship Satisfaction (P, T1) → Negative Provided Control (P, T2)→ SB (P, T2) + Relationship Satisfaction (P, T1) → SB (P, T3)	**19.268**	**9.523**	**0.110**	**37.486**	**.048**

Note. Values of indirect effect estimates presented in bold are significant at $p < .05$; Each bootstrap was based on 10,000 repetitions; BCI = Bias-corrected confidence intervals; BCI that do not include zero indicate a significant indirect effect; T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; SB = Sedentary Behavior Time.

Supplementary Table 10

Direct Effect for the 'Relationship Satisfaction → Social Control → SB Time' Model Tested with Additional Covariates

Variables and hypothesized associations	**B**	***SE***	***β***	***p***
Relationship Satisfaction (CH, T1) → Positive Received Control (CH, T2)	0.418	0.090	.296	**<.001**
Relationship Satisfaction (CH, T1) → Positive Provided Control (P, T2)	0.026	0.075	.024	.730
Relationship Satisfaction (CH, T1) → Negative Received Control (CH, T2)	**0.192**	**0.092**	**.143**	**.036**
Relationship Satisfaction (CH, T1) → Negative Provided Control (P, T2)	-0.033	0.077	-.029	.669
Relationship Satisfaction (CH, T1) → Sedentary Behavior (CH, T3)	-3.587	7.357	-.026	.626
Relationship Satisfaction (CH, T1) → Sedentary Behavior (P, T3)	-8.902	6.964	-.060	.201
Relationship Satisfaction (P, T1) → Positive Received Control (CH, T2)	0.210	0.117	.115	.072
Relationship Satisfaction (P, T1) → Positive Provided Control (P, T2)	0.123	0.097	.086	.208
Relationship Satisfaction (P, T1) → Negative Received Control (CH, T2)	-0.022	0.119	-.013	.850
Relationship Satisfaction (P, T1) → Negative Provided Control (P, T2)	-0.071	0.100	-.049	.476
Relationship Satisfaction (P, T1) → Sedentary Behavior (CH, T3)	5.636	9.281	.032	.544
Relationship Satisfaction (P, T1) → Sedentary Behavior (P, T3)	**20.163**	**8.814**	**.105**	**.022**
Sedentary Behavior (CH, T1) → Sedentary Behavior (CH, T3)	**0.413**	**0.043**	**.484**	**<.001**
Sedentary Behavior (P, T1) → Sedentary Behavior (P, T3)	**0.506**	**0.036**	**.630**	**<.001**
Positive Received Control (CH, T2)→ Sedentary Behavior (CH, T3)	-5.237	6.761	-.054	.439
Positive Received Control (CH, T2)→ Sedentary Behavior (P, T3)	-6.900	6.297	-.066	.281
Positive Provided Control (P, T2)→ Sedentary Behavior (CH, T3)	0.132	6.974	.001	.985
Positive Provided Control (P, T2)→ Sedentary Behavior (P, T3)	6.386	6.616	.047	.334
Negative Received Control (CH, T2)→ Sedentary Behavior (CH, T3)	1.177	6.935	.012	.865
Negative Received Control (CH, T2)→ Sedentary Behavior (P, T3)	3.418	6.566	.031	.603
Negative Provided Control (P, T2)→ Sedentary Behavior (CH, T3)	-7.942	7.081	-.065	.262
Negative Provided Control (P, T2)→ Sedentary Behavior (P, T3)	-0.256	6.717	-.002	.970

Note. T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; Significant coefficients are marked in bold; Model Fit: $\chi^2(130) = 169.587$, $p = .011$, $\chi^2/df = 1.305$, NFI = .877, CFI = .965, RMSEA = .035 (90% CI: .018, .049); Additional Covariates are: Age, Gender, Parent's Education, Parent's Economic Status, Intention to Reduce SB and Experimental Group Assignment.

Supplementary Table 11

Indirect Effects for the 'Relationship Satisfaction →Social Control → SB Time' Model Tested with Additional Covariates

Simple indirect effects, total indirect effect, direct effect, total effect		Estimate	*SE*	95%BCI		
				Lower	Upper	*p*
Simple indirect effects	Relationship Satisfaction (CH, T1)→ Positive Received Control (CH, T2)→ SB (CH, T3)	-2.189	3.425	-10.489	3.507	.403
	Relationship Satisfaction (CH, T1)→ Positive Provided Control (P, T2)→ SB (CH, T3)	0.003	0.704	-1.494	1.581	.977
	Relationship Satisfaction (CH, T1)→ Negative Received Control (CH, T2)→ SB (CH, T3)	0.226	1.846	-2.729	5.284	.753
	Relationship Satisfaction (CH, T1)→ Negative Provided Control (P, T2)→ SB (CH, T3)	0.260	0.852	- 0.591	3.708	.367
Direct effect	Relationship Satisfaction (CH, T1) → SB (CH, T3)	-3.587	6.622	-16.709	9.502	.584
Total indirect effect	Relationship Satisfaction (CH, T1)→ Positive Received Control (CH, T2)→ SB (CH, T3) + Relationship Satisfaction (CH, T1)→ Positive Provided Control (P, T2)→ SB (CH, T3) + Relationship Satisfaction (CH, T1) → Negative Received Control (CH, T2)→ SB (CH, T3) + Relationship Satisfaction (CH, T1) → Negative Provided Control (P, T2)→ SB (CH, T3)	-1.699	2.924	-8.248	3.624	.471
Total effect	Relationship Satisfaction (CH, T1) → Positive Received Control (CH, T2)→ SB (CH, T3) + Relationship Satisfaction (CH, T1) → Positive Provided Control (P, T2)→ SB (CH, T3) + Relationship Satisfaction (CH, T1) → Negative Received Control (CH, T2)→ SB (CH, T3) + Relationship Satisfaction (CH, T1) → Negative Provided Control (P, T2)→ SB (CH, T3) + Relationship Satisfaction (CH, T1) → SB (CH, T3)	-5.286	6.349	-18.465	6.592	.382
Simple indirect effects	Relationship Satisfaction (CH, T1) → Positive Received Control (CH, T2)→ SB (P, T3)	-2.884	3.241	-10.394	2.673	.281
	Relationship Satisfaction (CH, T1) → Positive Provided Control (P, T2)→ SB (P, T3)	0.165	0.774	-0.692	3.020	.503
	Relationship Satisfaction (CH, T1)→ Negative Received Control (CH, T2)→ SB (P, T3)	0.648	1.640	-2.018	4.819	.412
	Relationship Satisfaction (CH, T1)→ Negative Provided Control (P, T2 → SB (P, T3)	0.008	0.559	-1.069	1.412	.972
Direct effect	Relationship Satisfaction (CH, T1) → SB (P, T3)	-8.902	7.999	-25.110	6.063	.242
Total indirect effect	Relationship Satisfaction (CH, T1) → Positive Received Control (CH, T2)→ SB (P, T3) + Relationship Satisfaction (CH, T1) → Positive Provided Control (P, T2)→ SB (P, T3) + Relationship Satisfaction (CH, T1) → Negative Received Control (CH, T2)→ SB (P, T3) + Relationship Satisfaction (CH, T1) → Negative Provided Control (P, T2)→ SB (P, T3)	-2.053	2.639	-7.960	2.534	.388
Total effect	Relationship Satisfaction (CH, T1) → Positive Received Control (CH, T2)→ SB (P, T3) + Relationship Satisfaction (CH, T1) → Positive Provided Control (P, T2)→ SB (P, T3) + Relationship Satisfaction (CH, T1) → Negative Received Control (CH, T2)→ SB (P, T3) + Relationship Satisfaction (CH, T1) → Negative Provided Control (P, T2)→ SB (P, T3) + Relationship Satisfaction (CH, T1) → SB (P, T3)	-10.955	7.377	-25.827	2.936	.126
Simple indirect effects	Relationship Satisfaction (P, T1) → Positive Received Control (CH, T2)→ SB (CH, T3)	-1.101	1.916	-7.059	1.377	.315
	Relationship Satisfaction (P, T1) → Positive Provided Control (P, T2)→ SB (CH, T3)	0.016	1.470	-2.807	3.417	.955

	Relationship Satisfaction (P, T1)→ Negative Received Control (CH, T2)→ SB (CH, T3)	-0.026	0.925	-2.475	1.662	.835
	Relationship Satisfaction (P, T1)→ Negative Provided Control (P, T2)→ SB (CH, T3)	0.564	1.213	-0.667	5.140	.292
Direct effect	Relationship Satisfaction (P, T1) → SB (CH, T3)	5.636	9.793	-14.308	24.479	.580
Total indirect effect	Relationship Satisfaction (P, T1) → Positive Received Control (CH, T2)→ SB (CH, T3) + Relationship Satisfaction (P, T1) → Positive Provided Control (P, T2)→ SB (CH, T3) + Relationship Satisfaction (P, T1) → Negative Received Control (CH, T2)→ SB (CH, T3) + Relationship Satisfaction (P, T1) → Negative Provided Control (P, T2)→ SB (CH, T3)	-0.548	2.664	-6.159	4.615	.794
Total effect	Relationship Satisfaction (P, T1) → Positive Received Control (CH, T2)→ SB (CH, T3) + Relationship Satisfaction (P, T1) → Positive Provided Control (P, T2)→ SB (CH, T3) + Relationship Satisfaction (P, T1) → Negative Received Control (CH, T2)→ SB (CH, T3) + Relationship Satisfaction (P, T1) → Negative Provided Control (P, T2)→ SB (CH, T3) + Relationship Satisfaction (P, T1) → SB (CH, T3)	5.088	9.630	-13.988	23.934	.588
Simple indirect effects	Relationship Satisfaction (P, T1) → Positive Received Control (CH, T2)→ SB (P, T3)	-1.451	1.805	-6.702	0.962	.200
	Relationship Satisfaction (P, T1) → Positive Provided Control (P, T2)→ SB (P, T3)	0.785	1.604	-0.671	6.785	.289
	Relationship Satisfaction (P, T1)→ Negative Received Control (CH, T2)→ SB (P, T3)	-0.077	0.925	-2.843	1.204	.581
	Relationship Satisfaction (P, T1)→ Negative Provided Control (P, T2)→ SB (P, T3)	0.018	0.871	-1.566	2.311	.839
Direct effect	Relationship Satisfaction (P, T1) → SB (P, T3)	**20.163**	**9.744**	**1.337**	**39.668**	**.036**
Total indirect effect	Relationship Satisfaction (P, T1) → Positive Received Control (CH, T2)→ SB (P, T3) + Relationship Satisfaction (P, T1) → Positive Provided Control (P, T2)→ SB (P, T3) + Relationship Satisfaction (P, T1) → Negative Received Control (CH, T2)→ SB (P T3) + Relationship Satisfaction (P, T1) → Negative Provided Control (P, T2)→ SB (P, T2)	-0.725	2.363	-5.476	3.887	.626
Total effect	Relationship Satisfaction (P, T1) → Positive Received Control (CH, T2)→ SB (P, T3) + Relationship Satisfaction (P, T1) → Positive Provided Control (P, T2)→ SB (P, T3) + Relationship Satisfaction (P, T1) → Negative Received Control (CH, T2)→ SB (P, T2) + Relationship Satisfaction (P, T1) → Negative Provided Control (P, T2)→ SB (P, T2) + Relationship Satisfaction (P, T1) → SB (P, T3)	**19.438**	**9.605**	**0.268**	**37.784**	**.047**

Note. Values of indirect effect estimates presented in bold are significant at $p < .05$; Each bootstrap was based on 10,000 repetitions; BCI = Bias-corrected confidence intervals; BCI that do not include zero indicate a significant indirect effect; T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; SB = Sedentary Behavior Time; Model Fit: $\chi^2(130) = 169.587$, $p = .011$, $\chi^2/df = 1.305$, NFI = .877, CFI = .965, RMSEA = .035 (90% CI: .018, .049); Additional Covariates are: Age, Gender, Parent's Education, Parent's Economic Status, Intention to Reduce SB and Experimental Group Assignment.

Supplementary Table 12
Covariances for the 'Relationship Satisfaction → Social Control → SB Time' Model Tested with Additional Covariates

Covariances			Estimate	*SE*	*p*
Positive Received Control (CH, T2)	←→	Negative Received Control (CH, T2)	**0.321**	**0.037**	**<.001**
Positive Received Control (CH, T2)	←→	Positive Provided Control (P, T2)	**0.086**	**0.026**	**<.001**
Positive Received Control (CH, T2)	←→	Negative Provided Control (P, T2)	0.050	0.026	.057
Positive Provided Control (P, T2)	←→	Negative Provided Control (P, T2)	**0.166**	**0.024**	**<.001**
Negative Received Control (CH, T2)	←→	Positive Provided Control (P, T2)	**0.096**	**0.026**	**<.001**
Negative Received Control (CH, T2)	←→	Negative Provided Control (P, T2)	**0.137**	**0.028**	**<.001**
Relationship Satisfaction (CH, T1)	←→	Relationship Satisfaction (P, T1)	**0.079**	**0.014**	**<.001**
Gender (CH)	←→	Positive Received Control (CH, T2)	-0.013	0.022	.549
Gender (CH)	←→	Positive Provided Control (P, T2)	-0.001	0.018	.968
Gender (CH)	←→	Negative Received Control (CH, T2)	-0.031	0.022	.151
Gender (CH)	←→	Negative Provided Control (P, T2)	-0.003	0.019	.884
Gender (CH)	←→	Relationship Satisfaction (CH, T1)	0.015	0.016	.351
Gender (CH)	←→	Relationship Satisfaction (P, T1)	0.016	0.013	.198
Gender (CH)	←→	Gender (P)	0.003	0.011	.754
Gender (CH)	←→	Sedentary Behavior (CH, T1)	3.912	2.352	.096
Gender (CH)	←→	Sedentary Behavior (P, T1)	2.383	2.728	.382
Gender (P)	←→	Positive Received Control (CH, T2)	-0.028	0.015	.064
Gender (P)	←→	Positive Provided Control (P, T2)	0.005	0.012	.696
Gender (P)	←→	Negative Received Control (CH, T2)	-0.012	0.015	.414
Gender (P)	←→	Negative Provided Control (P, T2)	0.023	0.013	.077
Gender (P)	←→	Relationship Satisfaction (CH, T1)	0.002	0.011	.892
Gender (P)	←→	Relationship Satisfaction (P, T1)	**0.023**	**0.009**	**.012**
Gender (P)	←→	Sedentary Behavior (CH, T1)	-0.803	1.603	.616
Gender (P)	←→	Sedentary Behavior (P, T1)	**-4.024**	**1.875**	**.032**
Age (CH)	←→	Positive Received Control (CH, T2)	**-0.127**	**0.051**	**.014**
Age (CH)	←→	Positive Provided Control (P, T2)	-0.053	0.043	.215
Age (CH)	←→	Negative Received Control (CH, T2)	**-0.135**	**0.052**	**.010**
Age (CH)	←→	Negative Provided Control (P, T2)	0.006	0.043	.893
Age (CH)	←→	Relationship Satisfaction (CH, T1)	-0.075	0.039	.056
Age (CH)	←→	Relationship Satisfaction (P, T1)	-0.031	0.030	.297
Age (CH)	←→	Age (P)	**1.066**	**0.385**	**.006**
Age (CH)	←→	Sedentary Behavior (CH, T1)	**28.330**	**6.248**	**<.001**
Age (CH)	←→	Sedentary Behavior (P, T1)	7.433	6.492	.252
Age (P)	←→	Positive Received Control (CH, T2)	-0.034	0.205	.867
Age (P)	←→	Positive Provided Control (P, T2)	-0.208	0.173	.228
Age (P)	←→	Negative Received Control (CH, T2)	0.026	0.207	.899
Age (P)	←→	Negative Provided Control (P, T2)	0.076	0.175	.662
Age (P)	←→	Relationship Satisfaction (CH, T1)	-0.160	0.156	.307
Age (P)	←→	Relationship Satisfaction (P, T1)	-0.028	0.119	.817

Age (P)	←→	Sedentary Behavior (CH, T1)	**92.006**	**24.774**	**<.001**
Age (P)	←→	Sedentary Behavior (P, T1)	43.853	26.388	.097
Education (P)	←→	Positive Received Control (CH, T2)	-0.005	0.059	.929
Education (P)	←→	Positive Provided Control (P, T2)	-0.032	0.050	.525
Education (P)	←→	Negative Received Control (CH, T2)	0.002	0.060	.970
Education (P)	←→	Negative Provided Control (P, T2)	-0.051	0.051	.318
Education (P)	←→	Relationship Satisfaction (CH, T1)	0.008	0.045	.856
Education (P)	←→	Relationship Satisfaction (P, T1)	0.006	0.035	.853
Education (P)	←→	Economic Situation (P)	**-0.229**	**0.080**	**.004**
Education (P)	←→	Sedentary Behavior (CH, T1)	-2.772	6.671	.678
Education (P)	←→	Sedentary Behavior (P, T1)	**34.769**	**8.443**	**<.001**
Economic Situation (P)	←→	Positive Received Control (CH, T2)	-0.032	0.037	.380
Economic Situation (P)	←→	Positive Provided Control (P, T2)	-0.006	0.031	.854
Economic Situation (P)	←→	Negative Received Control (CH, T2)	**-0.085**	**0.037**	**.024**
Economic Situation (P)	←→	Negative Provided Control (P, T2)	-0.003	0.031	.920
Economic Situation (P)	←→	Relationship Satisfaction (CH, T1)	-0.038	0.028	.176
Economic Situation (P)	←→	Relationship Satisfaction (P, T1)	-0.030	0.022	.165
Economic Situation (P)	←→	Sedentary Behavior (CH, T1)	-2.337	3.980	.557
Economic Situation (P)	←→	Sedentary Behavior (P, T1)	**-12.712**	**4.879**	**.009**
Intention SB (CH, T1)	←→	Positive Received Control (CH, T2)	0.043	0.026	.103
Intention SB (CH, T1)	←→	Negative Received Control (CH, T2)	0.030	0.025	.232
Intention SB (CH, T1)	←→	Relationship Satisfaction (CH, T1)	**0.042**	**0.020**	**.032**
Intention SB (CH, T1)	←→	Intention SB (P, T1)	**0.066**	**0.027**	**.013**
Intention SB (P, T1)	←→	Positive Provided Control (P, T2)	0.011	0.023	.646
Intention SB (P, T1)	←→	Negative Provided Control (P, T2)	0.001	0.022	.955
Intention SB (P, T1)	←→	Relationship Satisfaction (P, T1)	0.014	0.015	.374
Sedentary Behavior (CH, T1)	←→	Sedentary Behavior (P, T1)	**2808.376**	**535.619**	**<.001**
Sedentary Behavior (CH, T3)	←→	Gender (CH)	-2.139	1.637	.191
Sedentary Behavior (CH, T3)	←→	Gender (P)	**-2.436**	**1.124**	**.030**
Sedentary Behavior (CH, T3)	←→	Age (CH)	**13.094**	**3.982**	**.001**
Sedentary Behavior (CH, T3)	←→	Age (P)	**38.505**	**16.029**	**.016**
Sedentary Behavior (CH, T3)	←→	Education (P)	**9.391**	**4.619**	**.042**
Sedentary Behavior (CH, T3)	←→	Economic Situation (P)	3.568	2.780	.199
Sedentary Behavior (CH, T3)	←→	Intention SB (CH, T1)	0.041	1.936	.983
Sedentary Behavior (CH, T3)	←→	Condition	-6.783	3.719	.068
Sedentary Behavior (CH, T3)	←→	Sedentary Behavior (P, T3)	**1373.131**	**247.409**	**<.001**
Sedentary Behavior (P, T3)	←→	Gender (CH)	-0.859	1.582	.587
Sedentary Behavior (P, T3)	←→	Gender (P)	-0.321	1.080	.766
Sedentary Behavior (P, T3)	←→	Age (CH)	1.246	3.689	.735
Sedentary Behavior (P, T3)	←→	Age (P)	14.019	15.088	.353
Sedentary Behavior (P, T3)	←→	Education (P)	**13.923**	**4.606**	**.003**
Sedentary Behavior (P, T3)	←→	Economic Situation (P)	-1.147	2.731	.674
Sedentary Behavior (P, T3)	←→	Intention SB (P, T1)	2.678	2.016	.184
Sedentary Behavior (P, T3)	←→	Condition	-0.378	3.609	.917
Weartime (CH, T1)	←→	Sedentary Behavior (CH, T1)	**30.308**	**5.697**	**<.001**
Weartime (CH, T1)	←→	Sedentary Behavior (P, T1)	5.192	5.992	.386
Weartime (CH, T1)	←→	Sedentary Behavior (CH, T3)	-2.556	3.399	.452
Weartime (CH, T1)	←→	Weartime (P, T1)	**0.560**	**0.091**	**<.001**

Weartime (CH, T1)	↔	Weartime (CH, T3)	**0.318**	**0.065**	**<.001**
Weartime (CH, T1)	↔	Weartime (P, T3)	**0.271**	**0.071**	**<.001**
Weartime (P, T1)	↔	Sedentary Behavior (CH, T1)	**18.644**	**5.472**	**<.001**
Weartime (P, T1)	↔	Sedentary Behavior (P, T1)	**38.287**	**7.399**	**<.001**
Weartime (P, T1)	↔	Sedentary Behavior (P, T3)	-6.971	3.781	.065
Weartime (P, T1)	↔	Weartime (CH, T3)	**0.235**	**0.064**	**<.001**
Weartime (P, T1)	↔	Weartime (P, T3)	**0.630**	**0.094**	**<.001**
Weartime (CH, T3)	↔	Sedentary Behavior (CH, T1)	**8.626**	**3.929**	**.028**
Weartime (CH, T3)	↔	Sedentary Behavior (CH, T3)	**27.824**	**3.961**	**<.001**
Weartime (CH, T3)	↔	Sedentary Behavior (P, T3)	**17.325**	**3.569**	**<.001**
Weartime (CH, T3)	↔	Weartime (P, T3)	**0.549**	**0.074**	**<.001**
Weartime (P, T3)	↔	Sedentary Behavior (P, T1)	6.074	5.462	.266
Weartime (P, T3)	↔	Sedentary Behavior (CH, T3)	**14.816**	**3.973**	**<.001**
Weartime (P, T3)	↔	Sedentary Behavior (P, T3)	**26.707**	**4.449**	**<.001**

Note. T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; SB = Sedentary Behavior Time; Intention SB = Intention to reduce SB at T1; Condition = the experimental condition (participating in a planning intervention) = 1, control (education) group = 0; Significant coefficients are marked in bold; Model Fit*:* $\chi^2(130) = 169.587$, $p = .011$, $\chi^2/df = 1.305$, NFI = .877, CFI = .965, RMSEA = .035 (90% CI: .018, .049); Additional Covariates are: Age, Gender, Parent's Education, Parent's Economic Status, Intention to Reduce SB and Experimental Group Assignment.

Supplementary Table 13

Direct Effects for the 'SB Time → Control → Relationship Satisfaction' Mediation Model

Variables and hypothesized associations	**B**	***SE***	***β***	***p***
Sedentary Behavior (CH, T1)→ Positive Received Control (CH, T2)	0.000	0.001	.058	.386
Sedentary Behavior (CH, T1) → Positive Provided Control (P, T2)	0.000	0.000	.030	.660
Sedentary Behavior (P, T1) → Positive Received Control (CH, T2)	**-0.002**	**0.001**	**-.222**	**<.001**
Sedentary Behavior (P, T1) → Positive Provided Control (P, T2)	0.000	0.000	-.058	.398
Sedentary Behavior (CH, T1)→ Negative Received Control (CH, T2)	0.001	0.001	.063	.352
Sedentary Behavior (CH, T1) → Negative Provided Control (P, T2)	0.000	0.000	.066	.331
Sedentary Behavior (P, T1) → Negative Received Control (CH, T2)	-0.001	0.000	-.119	.079
Sedentary Behavior (P, T1) → Negative Provided Control (P, T2)	0.000	0.000	-.028	.684
Sedentary Behavior (CH, T1)→ Relationship Satisfaction (CH, T3)	**-0.001**	**0.000**	**-.210**	**<.001**
Sedentary Behavior (CH, T1)→ Relationship Satisfaction (P, T3)	**-0.001**	**0.000**	**-.104**	**.048**
Sedentary Behavior (P, T1)→ Relationship Satisfaction (CH, T3)	0.001	0.000	.106	.061
Sedentary Behavior (P, T1)→ Relationship Satisfaction (P, T3)	0.000	0.000	.099	.065
Relationship Satisfaction (CH, T1) → Relationship Satisfaction (CH, T3)	**0.520**	**0.051**	**.520**	**<.001**
Relationship Satisfaction (P, T1) → Relationship Satisfaction (P, T3)	**0.652**	**0.051**	**.618**	**<.001**
Positive Received Control (CH, T2)→ Relationship Satisfaction (CH, T3)	**0.123**	**0.051**	**.174**	**.017**
Positive Received Control (CH, T2)→ Relationship Satisfaction (P, T3)	**0.101**	**0.039**	**.175**	**.010**
Positive Provided Control (P, T2)→ Relationship Satisfaction (CH, T3)	-0.106	0.055	-.117	.055
Positive Provided Control (P, T2)→ Relationship Satisfaction (P, T3)	-0.024	0.042	-.032	.573
Negative Received Control (CH, T2)→ Relationship Satisfaction (CH, T3)	-0.105	0.055	-.142	.055
Negative Received Control (CH, T2)→ Relationship Satisfaction (P, T3)	-0.035	0.042	-.058	.403
Negative Provided Control (P, T2)→ Relationship Satisfaction (CH, T3)	0.027	0.056	.030	.636
Negative Provided Control (P, T2)→ Relationship Satisfaction (P, T3)	-0.015	0.043	-.020	.732

Note. T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; Significant coefficients are marked in bold; Model Fit: $\chi^2(30) = 74.320$, $p < .001$, $\chi^2/df = 2.477$, NFI = .906, CFI = .939, RMSEA = .077 (90% CI: .056, .100).

Supplementary Table 14

Indirect Effects for the 'SB Time → Control → Relationship Satisfaction' Mediation Model

Simple indirect effects, total indirect effect, direct effect, total effect		Estimate	*SE*	95%BCI		
				Lower	Upper	*p*
Simple indirect effects	SB (CH, T1)→ Positive Received Control (CH, T2)→ Relationship Satisfaction (CH, T3)	0.000	0.000	0.000	0.000	.263
	SB (CH, T1) → Positive Provided Control (P, T2)→ Relationship Satisfaction (CH, T3)	0.000	0.000	0.000	0.000	.498
	SB (CH, T1)→ Negative Received Control (CH, T2)→ Relationship Satisfaction (CH, T3)	0.000	0.000	0.000	0.000	.275
	SB (CH, T1)→ Negative Provided Control (P, T2)→ Relationship Satisfaction (CH, T3)	0.000	0.000	0.000	0.000	.451
Direct effect	SB (CH, T1) → Relationship Satisfaction (CH, T3)	**-0.001**	**0.000**	**-0.002**	**-0.001**	**<.001**
Total indirect effect	SB (CH, T1)→ Positive Received Control (CH, T2)→ Relationship Satisfaction (CH, T3) + SB (CH, T1)→ Positive Provided Control (P, T2)→ Relationship Satisfaction (CH, T3) + SB (CH, T1) → Negative Received Control (CH, T2)→ Relationship Satisfaction (CH, T3) + SB (CH, T1) → Negative Provided Control (P, T2)→ Relationship Satisfaction (CH, T3)	0.000	0.000	0.000	0.000	.995
Total effect	SB (CH, T1) → Positive Received Control (CH, T2)→ Relationship Satisfaction (CH, T3) + SB (CH, T1) → Positive Provided Control (P, T2)→ Relationship Satisfaction (CH, T3) + SB (CH, T1) → Negative Received Control (CH, T2)→ Relationship Satisfaction (CH, T3) + SB (CH, T1) → Negative Provided Control (P, T2)→ Relationship Satisfaction (CH, T3) + SB (CH, T1) → Relationship Satisfaction (CH, T3)	**-0.001**	**0.000**	**-0.002**	**-0.001**	**<.001**
Simple indirect effects	SB (CH, T1) → Positive Received Control (CH, T2)→ Relationship Satisfaction (P, T3)	0.000	0.000	0.000	0.000	.251
	SB (CH, T1) → Positive Provided Control (P, T2)→ Relationship Satisfaction (P, T3)	0.000	0.000	0.000	0.000	.494
	SB (CH, T1)→ Negative Received Control (CH, T2)→ Relationship Satisfaction (P, T3)	0.000	0.000	0.000	0.000	.262
	SB (CH, T1)→ Negative Provided Control (P, T2 → Relationship Satisfaction (P, T3)	0.000	0.000	0.000	0.000	.488
Direct effect	SB (CH, T1) → Relationship Satisfaction (P, T3)	**-0.001**	**0.000**	**-0.001**	**0.000**	**.039**
Total indirect effect	SB (CH, T1) → Positive Received Control (CH, T2)→ Relationship Satisfaction (P, T3) + SB (CH, T1) → Positive Provided Control (P, T2)→ Relationship Satisfaction (P, T3) + SB (CH, T1) → Negative Received Control (CH, T2)→ Relationship Satisfaction (P, T3) + SB (CH, T1) → Negative Provided Control (P, T2)→ Relationship Satisfaction (P, T3)	0.000	0.000	0.000	0.000	.764
Total effect	SB (CH, T1) → Positive Received Control (CH, T2)→ Relationship Satisfaction (P, T3) + SB (CH, T1) → Positive Provided Control (P, T2)→ Relationship Satisfaction (P, T3) + SB (CH, T1) → Negative Received Control (CH, T2)→ Relationship Satisfaction (P, T3) + SB (CH, T1) → Negative Provided Control (P, T2)→ Relationship Satisfaction (P, T3) + SB (CH, T1) → Relationship Satisfaction (P, T3)	-0.000	0.000	-0.001	0.000	.051
Simple indirect effects	SB (P, T1) → Positive Received Control (CH, T2)→ Relationship Satisfaction (CH, T3)	**0.000**	**0.000**	**0.000**	**0.000**	**.011**
	SB (P, T1) → Positive Provided Control (P, T2)→ Relationship Satisfaction (CH, T3)	0.000	0.000	0.000	0.000	.285
	SB (P, T1)→ Negative Received Control (CH, T2)→ Relationship Satisfaction (CH, T3)	0.000	0.000	0.000	0.000	.065
	SB (P, T1)→ Negative Provided Control (P, T2)→ Relationship Satisfaction (CH, T3)	0.000	0.000	0.000	0.000	.569

Direct effect	SB (P, T1) → Relationship Satisfaction (CH, T3)	**0.001**	**0.000**	**0.000**	**0.001**	**.031**
Total indirect effect	SB (P, T1) → Positive Received Control (CH, T2)→ Relationship Satisfaction (CH, T3) + SB (P, T1) → Positive Provided Control (P, T2)→ Relationship Satisfaction (CH, T3) + SB (P, T1) → Negative Received Control (CH, T2)→ Relationship Satisfaction (CH, T3) + SB (P, T1) → Negative Provided Control (P, T2)→ Relationship Satisfaction (CH, T3)	0.000	0.000	0.000	0.000	.351
Total effect	SB (P, T1) → Positive Received Control (CH, T2)→ Relationship Satisfaction (CH, T3) + SB (P, T1) → Positive Provided Control (P, T2)→ Relationship Satisfaction (CH, T3) + SB (P, T1) → Negative Received Control (CH, T2)→ Relationship Satisfaction (CH, T3) + SB (P, T1) → Negative Provided Control (P, T2)→ Relationship Satisfaction (CH, T3) + SB (P, T1) → Relationship Satisfaction (CH, T3)	0.000	0.000	0.000	0.001	.077
Simple indirect effects	SB (P, T1) → Positive Received Control (CH, T2)→ Relationship Satisfaction (P, T3)	**0.000**	**0.000**	**0.000**	**0.000**	**.009**
	SB (P, T1) → Positive Provided Control (P, T2)→ Relationship Satisfaction (P, T3)	0.000	0.000	0.000	0.000	.413
	SB (P, T1)→ Negative Received Control (CH, T2)→ Relationship Satisfaction (P, T3)	0.000	0.000	0.000	0.000	.250
	SB (P, T1)→ Negative Provided Control (P, T2) → Relationship Satisfaction (P, T3)	0.000	0.000	0.000	0.000	.638
Direct effect	SB (P, T1) → Relationship Satisfaction (P, T3)	0.000	0.000	0.000	0.001	.100
Total indirect effect	SB (P, T1) → Positive Received Control (CH, T2)→ Relationship Satisfaction (P, T3) + SB (P, T1) → Positive Provided Control (P, T2)→ Relationship Satisfaction (P, T3) + SB (P, T1) → Negative Received Control (CH, T2)→ Relationship Satisfaction (P T3) + SB (P, T1) → Negative Provided Control (P, T2)→ Relationship Satisfaction (P, T2)	**0.000**	**0.000**	**0.000**	**0.000**	**.029**
Total effect	SB (P, T1) → Positive Received Control (CH, T2)→ Relationship Satisfaction (P, T3) + SB (P, T1) → Positive Provided Control (P, T2)→ Relationship Satisfaction (P, T3) + SB (P, T1) → Negative Received Control (CH, T2) →Relationship Satisfaction (P, T2) + SB (P, T1) → Negative Provided Control (P, T2)→ Relationship Satisfaction (P, T2) + SB (P, T1) → Relationship Satisfaction (P, T3)	0.000	0.000	0.000	0.000	.236

Note. Values of indirect effect estimates presented in bold are significant at $p < .05$; Each bootstrap was based on 10,000 repetitions; BCI = Bias-corrected confidence intervals; BCI that do not include zero indicate a significant indirect effect; T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; Model Fit*:* $\chi^2(30) = 74.320$, $p < .001$, $\chi^2/df = 2.477$, NFI = .906, CFI = .939, RMSEA = .077 (90% CI: .056, .100).

Supplementary Table 15

Covariances for the 'SB Time → Control → Relationship Satisfaction' Mediation Model

	Covariances		Estimate	*SE*	*p*
Positive Received Control (CH, T2)	←→	Positive Provided Control (P, T2)	**0.097**	**0.027**	**<.001**
Positive Received Control (CH, T2)	←→	Negative Received Control (CH, T2)	**0.335**	**0.039**	**<.001**
Positive Received Control (CH, T2)	←→	Negative Provided Control (P, T2)	0.041	0.027	.131
Positive Provided Control (P, T2)	←→	Negative Provided Control (P, T2)	**0.163**	**0.024**	**<.001**
Negative Received Control (CH, T2)	←→	Positive Provided Control (P, T2)	**0.098**	**0.027**	**<.001**
Negative Received Control (CH, T2)	←→	Negative Provided Control (P, T2)	**0.335**	**0.039**	**<.001**
Sedentary Behavior (CH, T1)	←→	Sedentary Behavior (P, T1)	**2963.769**	**568.292**	**<.001**
Relationship Satisfaction (CH, T1)	←→	Relationship Satisfaction (P, T1)	**0.079**	**0.014**	**<.001**
Relationship Satisfaction (CH, T3)	←→	Relationship Satisfaction (P, T3)	**0.020**	**0.009**	**.023**
Weartime (CH, T1)	←→	Sedentary Behavior (CH, T1)	**36.670**	**6.491**	**<.001**
Weartime (CH, T1)	←→	Sedentary Behavior (P, T1)	3.297	6.924	.634
Weartime (CH, T1)	←→	Weartime (P, T1)	**0.604**	**0.097**	**<.001**
Weartime (P, T1)	←→	Sedentary Behavior (CH, T1)	**30.318**	**7.160**	**<.001**
Weartime (P, T1)	←→	Sedentary Behavior (P, T1)	**41.384**	**8.310**	**<.001**

Note. T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; Weartime = average number of hours of wearing the accelerometer per day; Significant coefficients are marked in bold; Model Fit*:* $\chi^2(30) = 74.320$, $p < .001$, $\chi^2/df = 2.477$, NFI = .906, CFI = .939, RMSEA = .077 (90% CI: .056, .100).

Supplementary Table 16

Direct Effects for the 'SB Time → Relationship Satisfaction → Control' Mediation Model

Variables and hypothesized associations	B	*SE*	*β*	*p*
Sedentary Behavior (CH, T1)→ Positive Received Control (CH, T3)	**-0.001**	**0.000**	**-.136**	**.016**
Sedentary Behavior (CH, T1) → Positive Provided Control (P, T3)	0.000	0.000	-.016	.786
Sedentary Behavior (P, T1) → Positive Received Control (CH, T3)	0.000	0.000	.004	.942
Sedentary Behavior (P, T1) → Positive Provided Control (P, T3)	0.000	0.000	-.004	.945
Sedentary Behavior (CH, T1)→ Negative Received Control (CH, T3)	0.000	0.000	.026	.655
Sedentary Behavior (CH, T1) → Negative Provided Control (P, T3)	-0.001	0.000	-.094	.080
Sedentary Behavior (P, T1) → Negative Received Control (CH, T3)	0.000	0.000	-.070	.233
Sedentary Behavior (P, T1) → Negative Provided Control (P, T3)	0.000	0.000	-.039	.469
Sedentary Behavior (CH, T1)→ Relationship Satisfaction (CH, T2)	0.000	0.000	-.036	.591
Sedentary Behavior (CH, T1)→ Relationship Satisfaction (P, T2)	0.000	0.000	-.004	.953
Sedentary Behavior (P, T1)→ Relationship Satisfaction (CH, T2)	0.000	0.000	-.079	.247
Sedentary Behavior (P, T1)→ Relationship Satisfaction (P, T2)	0.000	0.000	-.030	.663
Relationship Satisfaction (CH, T1)→ Positive Received Control (CH, T3)	**0.199**	**0.072**	**.168**	**.005**
Relationship Satisfaction (CH, T1) → Positive Provided Control (P, T3)	0.097	0.096	.061	.311
Relationship Satisfaction (P, T1) → Positive Received Control (CH, T3)	0.005	0.058	.006	.926
Relationship Satisfaction (P, T1) → Positive Provided Control (P, T3)	**0.183**	**0.078**	**.144**	**.020**
Relationship Satisfaction (CH, T1)→ Negative Received Control (CH, T3)	**0.250**	**0.075**	**.207**	**<.001**
Relationship Satisfaction (CH, T1) → Negative Provided Control (P, T3)	0.072	0.101	.044	.474
Relationship Satisfaction (P, T1) → Negative Received Control (CH, T3)	0.032	0.056	.033	.566
Relationship Satisfaction (P, T1) → Negative Provided Control (P, T3)	0.049	0.075	.037	.511
Positive Received Control (CH, T1)→ Positive Received Control (CH, T3)	**0.411**	**0.038**	**.502**	**<.001**
Positive Provided Control (P, T1)→ Positive Provided Control (P, T3)	**0.418**	**0.041**	**.501**	**<.001**
Negative Received Control (CH, T1)→ Negative Received Control (CH, T3)	**0.376**	**0.041**	**.453**	**<.001**
Negative Provided Control (P, T1)→ Negative Provided Control (P, T3)	**0.473**	**0.036**	**.606**	**<.001**

Note. T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; Significant coefficients are marked in bold; Model Fit*:* $\chi^2(48) = 97.401$, $p < .001$, $\chi^2/df = 2.029$, NFI = .918, CFI = .955, RMSEA = .065 (90% CI: .046, .083).

Supplementary Table 17

Indirect Effects for the 'SB Time → Relationship Satisfaction → Control' Mediation Model

Simple indirect effects, total indirect effect, direct effect, total effect		**Estimate**	***SE***	**95%BCI**		***p***
				Lower	**Upper**	
Simple indirect effects	Sedentary Behavior (CH, T1) →Relationship Satisfaction (CH, T2) → Positive Received Control (CH, T3)	0.000	0.000	0.000	0.000	.471
	Sedentary Behavior (CH, T1) → Relationship Satisfaction (P, T2) → Positive Received Control (CH, T3)	0.000	0.000	0.000	0.000	.812
Direct effect	Sedentary Behavior(CH, T1) → Positive Received Control (CH, T3)	**-0.001**	**0.000**	**-0.002**	**0.000**	**.032**
Total indirect effect	Sedentary Behavior (CH, T1) →Relationship Satisfaction (CH, T2) → Positive Received Control (CH, T3) + Sedentary Behavior (CH, T1) → Relationship Satisfaction (P, T2) → Positive Received Control (CH, T3)	0.000	0.000	0.000	0.000	.589
Total effect	Sedentary Behavior (CH, T1) →Relationship Satisfaction (CH, T2) → Positive Received Control (CH, T3) + Sedentary Behavior (CH, T1) → Relationship Satisfaction (P, T2) → Positive Received Control (CH, T3) + Sedentary Behavior (CH, T1) → Positive Received Control (CH, T3)	**-0.001**	**0.000**	**-0.002**	**0.000**	**.027**
Simple indirect effects	Sedentary Behavior (CH, T1) →Relationship Satisfaction (CH, T2) → Negative Received Control (CH, T3)	0.000	0.000	0.000	0.000	.531
	Sedentary Behavior (CH, T1) → Relationship Satisfaction (P, T2) → Negative Received Control (CH, T3)	0.000	0.000	0.000	0.000	.807
Direct effect	Sedentary Behavior(CH, T1) → Negative Received Control (CH, T3)	0.000	0.000	-0.001	0.001	.667
Total indirect effect	Sedentary Behavior (CH, T1) →Relationship Satisfaction (CH, T2) → Negative Received Control (CH, T3) + Sedentary Behavior (CH, T1) → Relationship Satisfaction (P, T2) → Negative Received Control (CH, T3)	0.000	0.000	0.000	0.000	.606
Total effect	Sedentary Behavior (CH, T1) →Relationship Satisfaction (CH, T2) → Negative Received Control (CH, T3) + Sedentary Behavior (CH, T1) → Relationship Satisfaction (P, T2) → Negative Received Control (CH, T3) + Sedentary Behavior (CH, T1) → Negative Received Control (CH, T3)	0.000	0.000	-0.001	0.001	.749
Simple indirect effects	Sedentary Behavior (CH, T1) →Relationship Satisfaction (CH, T2) → Positive Provided Control (P, T3)	0.000	0.000	0.000	0.000	.701
	Sedentary Behavior (CH, T1) → Relationship Satisfaction (P, T2) → Positive Provided Control (P, T3)	0.000	0.000	0.000	0.000	.904
Direct effect	Sedentary Behavior(CH, T1) → Positive Provided Control (P, T3)	0.000	0.000	-0.001	0.001	.858
Total indirect effect	Sedentary Behavior (CH, T1) →Relationship Satisfaction (CH, T2) → Positive ProvidedControl (P, T3) + Sedentary Behavior (CH, T1) → Relationship Satisfaction (P, T2) → Positive Provided Control (P, T3)	0.000	0.000	0.000	0.000	.838
Total effect	Sedentary Behavior (CH, T1) →Relationship Satisfaction (CH, T2) → Positive Provided Control (P, T3) + Sedentary Behavior (CH, T1) → Relationship Satisfaction (P, T2) → Positive Provided Control (P, T3) + Sedentary Behavior (CH, T1) → Positive Provided Control (P, T3)	0.000	0.000	-0.001	0.001	.837
Simple indirect effects	Sedentary Behavior (CH, T1) →Relationship Satisfaction (CH, T2) → Negative Provided Control (P, T3)	0.000	0.000	0.000	0.000	.430
	Sedentary Behavior (CH, T1) → Relationship Satisfaction (P, T2) → Negative Provided Control (P, T3)	0.000	0.000	0.000	0.000	.829
Direct effect	Sedentary Behavior(CH, T1) → Negative Provided Control (P, T3)	-0.001	0.000	-0.001	0.000	.131
Total indirect effect	Sedentary Behavior (CH, T1) →Relationship Satisfaction (CH, T2) → Negative Provided Control (P, T3) + Sedentary Behavior (CH, T1) → Relationship Satisfaction (P, T2) → Negative Provided Control (P, T3)	0.000	0.000	0.000	0.000	.632

Total effect	Sedentary Behavior (CH, T1) →Relationship Satisfaction (CH, T2) → Negative Received Control (CH, T3) + Sedentary Behavior (CH, T1) → Relationship Satisfaction (P, T2) → Negative Provided Control (P, T3) + Sedentary Behavior (CH, T1) → Negative Provided Control (P, T3)	-0.001	0.000	-0.001	0.000	.119
Simple indirect effects	Sedentary Behavior (P, T1) →Relationship Satisfaction (CH, T2) → Positive Received Control (CH, T3)	0.000	0.000	0.000	0.000	.110
	Sedentary Behavior (P, T1) → Relationship Satisfaction (P, T2) → Positive Received Control (CH, T3)	0.000	0.000	0.000	0.000	.438
Direct effect	Sedentary Behavior(P, T1) → Positive Received Control (CH, T3)	0.000	0.000	-0.001	0.001	.937
Total indirect effect	Sedentary Behavior (P, T1) →Relationship Satisfaction (CH, T2) → Positive Received Control (CH, T3) + Sedentary Behavior (P, T1) → Relationship Satisfaction (P, T2) → Positive Received Control (CH, T3)	0.000	0.000	0.000	0.000	.182
Total effect	Sedentary Behavior (P, T1) →Relationship Satisfaction (CH, T2) → Positive Received Control (CH, T3) + Sedentary Behavior (P, T1) → Relationship Satisfaction (P, T2) → Positive Received Control (CH, T3) + Sedentary Behavior (P, T1) → Positive Received Control (CH, T3)	0.000	0.000	-0.001	0.001	.837
Simple indirect effects	Sedentary Behavior (P, T1) →Relationship Satisfaction (CH, T2) → Negative Received Control (CH, T3)	0.000	0.000	0.000	0.000	.131
	Sedentary Behavior (P, T1) → Relationship Satisfaction (P, T2) → Negative Received Control (CH, T3)	0.000	0.000	0.000	0.000	.458
Direct effect	Sedentary Behavior (P, T1) → Negative Received Control (CH, T3)	0.000	0.000	-0.001	0.000	.242
Total indirect effect	Sedentary Behavior (P, T1) →Relationship Satisfaction (CH, T2) → Negative Received Control (CH, T3) + Sedentary Behavior (P, T1) → Relationship Satisfaction (P, T2) → Negative Received Control (CH, T3)	0.000	0.000	0.000	0.000	.184
Total effect	Sedentary Behavior (P, T1) →Relationship Satisfaction (CH, T2) → Negative Received Control (CH, T3) + Sedentary Behavior (P, T1) → Relationship Satisfaction (P, T2) → Negative Received Control (CH, T3) + Sedentary Behavior (P, T1) → Negative Received Control (CH, T3)	-0.001	0.000	-0.001	0.000	.144
Simple indirect effects	Sedentary Behavior (P, T1) →Relationship Satisfaction (CH, T2) → Positive Provided Control (P, T3)	0.000	0.000	0.000	0.000	.782
	Sedentary Behavior (P, T1) → Relationship Satisfaction (P, T2) → Positive Provided Control (P, T3)	0.000	0.000	0.000	0.000	.520
Direct effect	Sedentary Behavior (P, T1) → Positive Provided Control (P, T3)	0.000	0.000	-0.001	0.001	.965
Total indirect effect	Sedentary Behavior (P, T1) →Relationship Satisfaction (CH, T2) → Positive Received Control (P, T3) + Sedentary Behavior (P, T1) → Relationship Satisfaction (P, T2) → Positive Provided Control (P, T3)	0.000	0.000	0.000	0.000	.609
Total effect	Sedentary Behavior (P, T1) →Relationship Satisfaction (CH, T2) → Positive Provided Control (P, T3) + Sedentary Behavior (P, T1) → Relationship Satisfaction (P, T2) → Positive Provided Control (P, T3) + Sedentary Behavior (P, T1) → Positive Provided Control (P, T3)	0.000	0.000	-0.001	0.001	.909
Simple indirect effects	Sedentary Behavior (P, T1) →Relationship Satisfaction (CH, T2) → Negative Provided Control (P, T3)	0.000	0.000	0.000	0.000	.460
	Sedentary Behavior (P, T1) → Relationship Satisfaction (P, T2) → Negative Provided Control (P, T3)	0.000	0.000	0.000	0.000	.425
Direct effect	Sedentary Behavior (P, T1) → Negative Provided Control (P, T3)	0.000	0.000	-0.001	0.000	.523
Total indirect effect	Sedentary Behavior (P, T1) →Relationship Satisfaction (CH, T2) → Negative Provided Control (P, T3) + Sedentary Behavior (P, T1) → Relationship Satisfaction (P, T2) → Negative Provided Control (P, T3)	0.000	0.000	0.000	0.000	.487

Total effect	Sedentary Behavior (P, T1) →Relationship Satisfaction (CH, T2) → Negative Provided Control (P, T3) + Sedentary Behavior (P, T1) → Relationship Satisfaction (P, T2) → Negative Provided Control (P, T3)+ Sedentary Behavior (P, T1) → Negative Provided Control (P, T3)	0.000	0.000	-0.001	0.000	.501

Note. Values of indirect effect estimates presented in bold are significant at $p < .05$; Each bootstrap was based on 10,000 repetitions; BCI = Bias-corrected confidence intervals; BCI that do not include zero indicate a significant indirect effect; T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; Model Fit*:* $\chi^2(48) = 97.401$, $p < .001$, $\chi^2/df = 2.029$, NFI = .918, CFI = .955, RMSEA = .065 (90% CI: .046, .083).

Supplementary Table 18

Covariances for the 'SB Time → Relationship Satisfaction → Control' Mediation Model

	Covariances				
			Estimate	***SE***	***p***
Positive Received Control (CH, T1)	←→	Positive Provided Control (P, T1)	**0.138**	**0.032**	**<.001**
Positive Received Control (CH, T1)	←→	Negative Received Control (CH, T1)	**0.441**	**0.048**	**<.001**
Positive Received Control (CH, T1)	←→	Negative Provided Control (P, T1)	**0.127**	**0.035**	**<.001**
Positive Provided Control (P, T1)	←→	Negative Provided Control (P, T1)	**0.203**	**0.029**	**<.001**
Negative Received Control (CH, T1)	←→	Positive Provided Control (P, T1)	**0.148**	**0.032**	**<.001**
Negative Received Control (CH, T1)	←→	Negative Provided Control (P, T1)	**0.217**	**0.037**	**<.001**
Positive Received Control (CH, T3)	←→	Positive Provided Control (P, T3)	**0.040**	**0.015**	**.008**
Positive Received Control (CH, T3)	←→	Negative Received Control (CH, T3)	**0.168**	**0.022**	**<.001**
Positive Received Control (CH, T3)	←→	Negative Provided Control (P, T3)	0.012	0.014	.386
Positive Provided Control (P, T3)	←→	Negative Provided Control (P, T3)	**0.076**	**0.012**	**<.001**
Negative Received Control (CH, T3)	←→	Positive Provided Control (P, T3)	0.012	0.015	.423
Negative Received Control (CH, T3)	←→	Negative Provided Control (P, T3)	0.024	0.015	.107
Sedentary Behavior (CH, T1)	←→	Sedentary Behavior (P, T1)	**2963.769**	**568.292**	**<.001**
Relationship Satisfaction (CH, T2)	←→	Relationship Satisfaction (P, T2)	**0.101**	**0.015**	**<.001**
Weartime (CH, T1)	←→	Sedentary Behavior (CH, T1)	**33.670**	**6.491**	**<.001**
Weartime (CH, T1)	←→	Sedentary Behavior (P, T1)	3.297	6.924	.634
Weartime (CH, T1)	←→	Weartime (P, T1)	**0.604**	**0.097**	**<.001**
Weartime (P, T1)	←→	Sedentary Behavior (CH, T1)	**30.318**	**7.160**	**<.001**
Weartime (P, T1)	←→	Sedentary Behavior (P, T1)	**41.384**	**8.310**	**<.001**

Note. T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; Weartime = average number of hours of wearing the accelerometer per day; Significant coefficients are marked in bold; Model Fit: $\chi^2(48) = 97.401$, $p < .001$, $\chi^2/df = 2.029$, NFI = .918, CFI = .955, RMSEA = .065 (90% CI: .046, .083).

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Associations between depressive symptoms and sedentary behaviors in dyads: Longitudinal crossover effects

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ABSTRACT

Objective: Evidence-based models linking depressive symptoms and sedentary behaviors suggest that they may both exacerbate each other, leading to a vicious cycle. While existing theory and research focus on within-individual associations between sedentary behaviors and depressive symptoms, this study investigated crossover effects (i.e., from one person to another) of sedentary behaviors of one person in the dyad on depressive symptoms in their partners. Second, we tested the crossover effects of depressive symptoms of one person in the dyad on sedentary behaviors in their partners.

Methods: Data from 320 dyads were analyzed using cross-lagged path models. Dyads included a person attempting to become more physically active (the focus person) and their partners, supporting behavior change of focus persons. Participants were 18–90 years old. Depressive symptoms were assessed with the Patient Health Questionnaire-9 and sedentary time was measured with GT3X-BT accelerometers at Time 1 (T1; baseline), Time 2 (T2; 8-month follow-up), and Time 3 (T3; 14-month follow-up).

Results: Significant time-lagged crossover effects were found: focus persons' depressive symptoms (T1) predicted partners' sedentary time (T2); partners' sedentary time (T1) predicted focus persons' depressive symptoms (T2); and focus persons' depressive symptoms (T2) predicted partners' sedentary time (T3). A significant indirect effect indicated that longer sedentary time among partners (T1) predicted more depressive symptoms among focus persons (T2), which in turn were associated with longer sedentary time among partners (T3).

Conclusions: The study provides preliminary support for a dyadic vicious cycle of sedentary behaviors and depressive symptoms.

1. Introduction

Sitting, reclining, or lying, along with other behaviors characterized by low energy expenditure of ≤1.5 Metabolic Equivalent Tasks (METs), are called sedentary behaviors (Tremblay et al., 2017). The World Health Organization (2020) recommends reducing sedentary time across all age groups and abilities due to their association with higher risk of all-cause and cardiovascular disease mortality, type-2 diabetes, and cancer (Patterson et al., 2018). Sedentary time increased over the last decades, with research conducted between 2007 and 2016 reporting a significant increase in sedentary behaviors from 5.7 h to 6.4 h among adults in the general population (Du et al., 2019).

In addition to associations between sedentary behaviors and physical health indicators (Patterson et al., 2018), there is growing evidence of significant associations between longer sedentary time and negative mental health outcomes, such as higher anxiety (Stanczykiewicz et al., 2019) and poorer quality of life (Boberska et al., 2018). Symptoms of depression are among the most frequently chosen mental health indicators in research testing associations between sedentary behaviors and mental health (Hallgren et al., 2020). Among other reasons, this is

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due to a high prevalence of depression in the population, affecting from 7% to 20% of people in their lifetime (Lim et al., 2018). Limited effectiveness of existing treatments for depression highlights the need for a better understanding of behavioral factors associated with depression onset and behavioral consequences of depression that may further increase the likelihood of depression relapse (Hallgren et al., 2020).

Associations between sedentary behaviors and subsequent depressive symptoms are significant but weak, as indicated in systematic reviews of prospective research (Huang et al., 2020). Reviews combining cross-sectional and prospective studies yielded small effects as well (Saunders et al., 2020). The associations between sedentary behaviors and depressive symptoms may vary depending on the type of sedentary behaviors and reach small-to-moderate effects for 'mentally passive' sedentary activities such as watching TV, compared to 'mentally active' sedentary behaviors such as reading a book (Hallgren et al., 2020). A vast majority of prospective research conducted to date used self-reported sedentary behaviors (e.g., 56 of 58 longitudinal studies included in a review by Zhang et al., 2022). Importantly, self-reported sedentary time substantially differs from accelerometer-based assessments (with self-reports indicating an average of 105 min per day lower, Prince et al., 2020). Therefore, the existing systematic reviews addressing sedentary behaviors and depressive symptoms are potentially biased by the relatively low reliability of self-reports. Recent research using accelerometer-based assessments of sedentary time suggested significant cross-sectional associations between sedentary behaviors and depressive symptoms (Appelqvist-Schmidlechner et al., 2022; Hsiao et al., 2022). Due to the cross-sectional design, it is impossible to establish the order in which sedentary behaviors and depressive symptoms may occur.

There are several mechanisms that may explain within-individual associations between sedentary behaviors and symptoms of depression. Sedentary behaviors may increase the risk for elevated depressive symptoms by limiting direct (in person) communication with others, increasing social isolation, and lowering overall levels of social interactions (Huang et al., 2020). High levels of depressive symptoms also increase the likelihood of replacing physical activity with more sedentary time, which in turn may reduce the likelihood of recovery or increase a risk of a relapse/recurrence of depression (Huang et al., 2020). Other models suggest that sedentary behaviors may be linked with higher levels of depressive symptoms via heightened inflammatory markers, which may form a mediating biological mechanism (Hamer & Smith, 2018). Evidence-based models linking depressive symptoms and sedentary time suggest that they may exacerbate each other. Sedentary behaviors may increase the likelihood of elevated symptoms of depression and higher depressive symptoms may increase the risk of longer sedentary time (Hallgren et al., 2020).

Besides mechanisms that may explain within-individual associations between sedentary behaviors and depressive symptoms, there are several theoretical models that suggest associations between health behaviors and mental health of two persons in a close relationship, such as romantic couples, close friends, or family members. The shared resources hypothesis suggests that romantic couples share a physical environment and social networks, and thus are likely to engage in similar behaviors and report similar moods (Meyler et al., 2007). This may be true for other dyads as well (e.g., close friends or close coworkers, and family members). The health behavior concordance hypothesis posits that social control may represent the convergence mechanism in which partners attempt to influence each other in order to affect each other's health behaviors or emotional responses (Meyler et al., 2007). The shared resources and social influence hypothesis may explain findings indicating a convergence and synchrony in accelerometer-assessed sedentary time found among romantic couples (Pauly et al., 2020). The mood convergence hypothesis assumes similarity or 'affective contagion' among couples, with cross-sectional research supporting the crossover associations in depressive symptoms (Meyler et al., 2007). Although the dyadic convergence mechanisms suggested by Meyler et al. (2007) were developed in the context of romantic couples, it seems plausible that they may apply to other types of dyads that share the physical environment and social networks.

According to the evidence-based Dyadic Health Influence Model (Huelsnitz et al., 2022), dyads involving two adults in a close relationship observe each other and influence each other's beliefs and behaviors via various social influence strategies (Huelsnitz et al., 2022). Thus, the crossover associations in health outcomes of the dyad members may be expected. Furthermore, a framework for investigating dyadic relationship processes and health suggests that health behaviors, affective outcomes (including depressive symptoms), social influence processes, and relationship-related factors are all interrelated within-individuals, but crossover effects from one person to other individuals are also expected (Pietromonaco et al., 2013). Longitudinal evidence for the crossover associations between accelerometer-measured sedentary behaviors and depressive symptoms is limited to mother-child dyads. For mothers who reported higher negative affect (compared to other mothers), their children spent more time sitting/reclining at short-term follow-ups (Yang et al., 2020). In contrast, Maher et al. (2017) found no associations between maternal depressive symptoms and children's physical activity and sedentary behaviors, assessed for the following seven days.

In sum, there are multiple models that suggest within-individual and crossover associations between sedentary behaviors and depressive symptoms. However, the ways in which depressive symptoms and sedentary behaviors are linked with each other are unclear. Research has usually tested either cross-sectional and/or within-individual associations between sedentary time and the levels of depressive symptoms. The abundance of self-report-based studies is in contrast to a lack of research using accelerometers to assess sedentary time. Within-individual research has dominated the field, whereas the evidence for dyadic associations is very limited. There is no empirical evidence for the order in which sedentary behaviors and depressive symptoms are linked in adult-adult dyads: do sedentary behaviors predict depressive symptoms or do depressive symptoms predict sedentary behaviors, or both?

To address this gap, the present study tested two hypothetical models, assuming crossover effects (from one person to another) in dyads including an adult focus person and their partner. First, we examined whether the focus persons' and partners' sedentary behaviors (Time 1; T1) would predict each other's depressive symptoms (measured at Time 2; T2, 8 months after T1), which in turn would predict each other's sedentary behaviors assessed at Time 3 (T3, 14 months after T1). Next, we examined whether the level of depressive symptoms assessed among focus persons and their partners at T1 would predict each other's sedentary behaviors at T2, which in turn would predict each other's depressive symptoms at T3.

Moderate-to-vigorous physical activity may constitute a key confounding variable when testing the association between physical activity and depressive symptoms (Blough & Loprinzi, 2018; Edwards & Loprinzi, 2016). Higher levels of physical activity are associated both with lower depressive symptoms and lower sedentary time (Edwards & Loprinzi, 2016). Therefore moderate-to-vigorous physical activity at T1 was included as a covariate in all analyses.

2. Method

2.1. Study design

This study reports secondary findings of a randomized controlled trial (preregistered at ClinicalTrials.gov, #NCT03011385). The trial investigated the effects of physical activity planning interventions (7 planning sessions/control procedures) combined with a healthy lifestyle education (addressing sedentary behaviors, physical activity, and a healthy diet). Besides the planning interventions or the control condition procedures, all focus persons and their partners took part in identical education sessions. The education sessions addressed sedentary

behavior definitions and patterns, health consequences of sedentary behaviors, including mental health issues, and ways to break sedentary bouts and reduce overall sedentary time. The 7 intervention sessions were delivered over 2 months. The primary outcomes were physical activity and sedentary behaviors assessed at 8 months after baseline. To date, the published reports from this trial present the effects of the intervention on physical activity and sedentary behaviors up to 8 months after baseline (Kulis et al., 2022; Szczuka et al., 2021), whereas this study additionally includes a 14-month assessment. The findings indicated no effects of a planning intervention on sedentary behaviors time at 8 months after baseline, among either the focus persons or their partners (Szczuka et al., 2021). Depression was not considered in previous studies from this dataset.

2.2. Participants

At Time 1, 320 focus person-partner adult dyads were enrolled in this study (320 focus persons and 320 partners). Time 3 measurement (14 months after T1) was completed by $n = 270$ focus persons and $n = 270$ partners, indicating that the total longitudinal dropout was 15.6%.

The inclusion criteria for dyads were: (1) focus persons and partners were $\geq$ 18 years old; (2) the dyad included (a) a distinguishable focus person, that is an individual who did not meet the WHO (2010) recommended thresholds of physical activity and/or was recommended by a specialist to reduce sedentary behaviors and increase their physical activity levels due to a chronic illness such as type-2 diabetes or cardiovascular diseases and (b) their partner; (3) focus persons reported at least moderate intentions to initiate regular moderate-to-vigorous physical activity; (4) the dyad was in a close relationship, defined as a romantic partner or another close relationship (family members, close friends, coworkers) involving several meetings each week; and (5) the relationship lasted $\geq$ 6 months.

Most dyads were in a romantic relationship (61%), whereas 39% of dyads were in other relationships (e.g., close friends, family members, workmates). All dyads were in a relationship for $>$ 6 months and they had at least several face-to-face meetings every week within the 6 months prior to this study. The sociodemographic characteristics of the focus persons and partners are presented in Table 1.

2.3. Procedures

T1 self-report was followed by 6 days of accelerometer-based measurement of sedentary behaviors; the same procedures were conducted at T2 (8 months after T1) and at T3 (14 months after T1). Data were collected individually (dyads completed questionnaires separately) during face-to-face meetings of a dyad with an experimenter.

Data were collected between December 2016 and October 2020 in 25 urban locations and 7 rural locations in Poland. Participants were recruited via advertisements published in social media or on websites of non-governmental organizations; recruitment was also conducted during municipality-held health promotion events. Potential participants were informed about the study aims and procedures. After familiarizing themselves with the study goals, participants were screened for eligibility and were asked to provide informed consent. Overall, 461 dyads were screened for eligibility; 141 either did not meet the inclusion criteria or decided not to take part in the study. The data files and outputs from main analyses are available at Open Science Framework, https://osf.io/5yrkn/.

The study was approved by the Ethics Committee at the first author's institution. There was no payment for participation; participants received a thank-you gift (value 5-10 EUR) after each measurement.

2.4. Measures

Means, standard deviations, and internal consistency coefficients are presented in Supplemental Material 1, Table S1.

Table 1
Sociodemographic characteristics of the study participants at baseline.

Variables	Focus persons' characteristics	Partners' characteristics
Age		
Mean (*SD*)	43.86 (*17.02*)	42.32 (*16.55*)
Minimum - maximum	18–90	18–84
Gender		
Men	35.6%	35.9%
Women	64.4%	64.1%
Education		
Primary	2.2%	1.3%
High school or vocational education	40.0%	41.9%
At least 3 years of higher education	57.2%	56.5%
Other	0.6%	0.3%
Economic status (compared to an average in the country)		
Below the average	5.6%	6.9%
The average	52.2%	49.1%
Above the average	42.2%	44.0%
A diagnosis of a chronic illness (e.g., type-2 diabetes, cardiovascular diseases)	68.4%	48.1%
Physical activity level at baseline		
Below the World Health Organization (2020) recommendation of 150 min per day	87.8%	77.5%
Depressive symptoms (based on thresholds applied to the scores of the Patient Health Questionnaire -9)		
No depression	36.3%	47.2%
Mild depression	43.4%	38.1%
Moderate depression	14.1%	9.7%
Moderately severe depression	4.0%	3.8%
Severe depression	2.2%	1.2%

2.4.1. Sedentary time (T1, T2, and T3)

Sedentary time data were measured using ActiGraph GT3X-BT accelerometers. Focus persons and partners were instructed about the use of the devices and were asked to report daily hours of wearing time for the following 6 days. Data obtained from each device were used in the analyses only if it had been worn for at least 8 h per day, for a minimum of 3 days during the corresponding time period (Prescott et al., 2020). Data scoring methods were based on the Freedson VM3 (Sasaki et al., 2011) and the Freedson Adult (Freedson et al., 1998) algorithms with the Actilife software (Sasaki et al., 2011). Non-wear time was calculated using an epoch-based algorithm based on Choi, Liu, Matthews, and Buchowski (2011); 10-s epochs were used for a better distinction between sedentary behaviors and physical activity (Quante et al., 2015). Sedentary time was calculated as the average minutes of sedentary behaviors per every day of device wearing time (adjusted for hours of wearing time). Data obtained during the first valid wear day at T1 were excluded. The following means and standard deviations were obtained for focus persons (FP) and partners (P) across time points: $M_{FP} = 504.95$, $SD_{FP} = 92.59$ and $M_P = 494.48$, $SD_P = 99.88$ at T1; $M_{FP} = 485.62$, $SD_{FP} = 89.55$ and $M_P = 477.57$, $SD_P = 87.13$ at T2; $M_{FP} = 478.36$, $SD_{FP} = 91.96$ and $M_P = 477.32$, $SD_P = 93.43$ at T3.

2.4.2. Depressive symptoms (T1, T2, and T3)

The Patient Health Questionnaire-9 (PHQ-9; Kroenke et al., 2001) was applied to screen for severity of depressive symptoms. The responses range from 0 to 3, depending on the frequency of a given symptom in the last two weeks (0 - not at all, 1 - several days, 2 - more than half the days, 3 - nearly every day). A score $<$ 5 indicates no depression, a score of 5–9 represents mild depression, 10-14 indicates moderate depression, 15-19 moderately severe depression, and a score $>$ 20 represents severe depression (Kroenke et al., 2001). The internal consistency was good with values of Cronbach's α ranging between 0.84 and 0.88 ($\alpha_{FP} = .84$, $\alpha_P = .84$ at T1; $\alpha_{FP} = .88$, $\alpha_P = .84$ at T2; $\alpha_{FP} = .85$, $\alpha_P = .85$ at T3). Mean scores of the study participants were within the range of mild depressive symptoms: $M_{FP} = 6.53$, $SD_{FP} = 4.78$ and $M_P = 5.57$, $SD_P = 4.47$ at T1; $M_{FP} = 5.30$, $SD_{FP} = 4.41$ and $M_P = 4.76$, $SD_P =$

3.72 at T2; $M_{FP} = 4.81$, $SD_{FP} = 3.94$ and $M_P = 4.33$, $SD_P = 3.55$ at T3.

2.4.3. Control variables

Focus persons' and partners' moderate-to-vigorous physical activity minutes per day at T1 were assessed with ActiGraph wGT3X-BT accelerometers, applying the Sasaki et al. (2011) algorithm. Daily minutes of moderate-to-vigorous physical activity for each valid wear day (excluding the first valid wear day) were summed up and divided by the number of valid wear days: $M_{FP} = 73.51$, $SD_{FP} = 30.46$ and $M_P = 81.56$, $SD_P = 31.09$.

Sociodemographic covariates used in the sensitivity analysis were: (1) age; (2) gender; (3) education (elementary, vocational, high school, post-secondary, bachelor, master, other); (4) self-reported socioeconomic status, with responses varying from 1 (much above the average family in Poland) to 5 (much below the average family in Poland); (5) the type of relationship (romantic relationship = 1, vs. other, i.e., close family relationship, close friendship, work-related relationship = 0); (6) a diagnosis of chronic disease (e.g., cardiovascular, diabetes or musculoskeletal = 1, vs. none = 0).

2.5. Data analysis

The G*Power calculator (simulating a multiple regression model) was used to conduct a priori calculations of the sample size. Assuming small effect sizes $f^2 = 0.05$ (in line with previous research on associations between sedentary behaviors and depression (Huang et al., 2020; Saunders et al., 2020), power of .90, Type I error rate of 0.05 and accounting for confounding effects of physical activity, the determined sample size was approximately 300 dyads.

Path analyses were performed using IBM AMOS version 26, using the maximum likelihood estimation. The two hypothesized models assumed that focus persons and partners were distinguishable, and accounted for three measurement points, with the independent, mediator, and dependent variables assessed at separate time points, controlling for T1-level of the dependent variable. Several model-data fit indices were applied. A cut-off point of $\leq .08$ for the root mean square error of approximation (RMSEA) was used (Byrne, 2010). A cut-off point of $\geq .95$, indicating good model-data fit, was applied for the comparative fit index (CFI) and the normed fit index (NFI) (Byrne, 2010). The indirect effects were evaluated with unstandardized effect coefficients, calculated with 10,000 bootstraps (95% CI). Missing data (including data missing due to dropouts at T2 and T3) were accounted for by using the full information maximum likelihood procedure (Byrne, 2010). Little's MCAR test indicated that the missing data patterns were systematic, Little's $\chi^2(N = 661) = 734.470$, $p = .025$. Values of Mardia's coefficient (13.22 and 16.29) indicated moderate multivariate non-normality.

2.5.1. Analytic strategy for the hypothesized models

All models assumed that persons within dyads were distinguishable, with roles set as focus persons and partners. Although models were estimated in line with recommendations for the actor-partner interdependence model with mediators (Ledermann et al., 2011), we refrain from using the terms 'actor' and 'partner' in describing the effects. The models were saturated in terms of the associations between the independent, mediator, and dependent variables, and their respective covariances (Ledermann et al., 2011). The independent variable indicators at T1, assessed in focus persons and partners, were assumed to predict T3 indicators of the dependent variables measured in both dyad members, via the mediators assessed in both dyad members. To account for the dyadic interdependence, the independent variables' indicators (T1) were assumed to covary; indicators of the control variable, moderate-to-vigorous physical activity (T1) measured in focus persons and partners, were also assumed to covary. Residuals of the mediators (T2) and sedentary behaviors (T3), measured in both persons in a dyad, were assumed to covary as well. Additionally, the confounding variable, moderate-to-vigorous physical activity of focus persons and partners was assumed to covary with the independent, mediator, and dependent variables assessed in the same individual.

Instead of using one model to test all mediation hypotheses, two hypothesized mediation models were calculated. This strategy allowed us to reduce the potential bias related to multicollinearity and prevented a reduction of the power of analysis related to a high number of parameters in the model (for a similar approach see e.g., Banik et al., 2021).

Several indirect effects were tested: (1) those with the independent, mediator, and dependent variables measured in one person; (2) those with at least one variable in the chain of 'the independent variable → the mediator → the dependent variable' measured in one person and at least one variable in this chain measured in the other person. The simple indirect effects were calculated using the user-defined estimands function (Amos Development Corporation, 2021).

Sensitivity analyses were conducted in order to assess the robustness of the findings. We examined whether the pattern of associations was similar in the hypothesized model and the model controlling for the type of relationship (romantic vs. other), presence of a chronic illness, focus persons' and partners' age, gender, education, economic status (T1), and finally, the effects of the experimental group assignment (1 = physical activity planning intervention, 0 = the control group) on the independent, mediator and dependent variables.

3. Results

3.1. Preliminary analyses

Among focus persons and partners, analyses for T1 data showed no differences between completers and drop-outs (see Supplemental Material 1).

Bivariate correlations among the study variables are presented in Supplemental Material 1, Table S2. Regarding associations among indicators of depressive symptoms, there were significant within-individual and crossover correlations, as well as within- and across-measurement points correlations, except for two non-significant associations: focus persons' depressive symptoms (T1) – partner's depressive symptoms (T3) and partners' depressive symptoms (T1) - focus persons' depressive symptoms (T3). Regarding sedentary behaviors, there were significant within-individuals and crossover correlations, as well as within- and across-measurement points correlations, except for two non-significant associations: focus persons' sedentary behaviors (T1) – partners' sedentary behaviors (T2) and focus persons' sedentary behaviors (T2) – partners' sedentary behaviors (T2). Finally, the correlation analysis indicated that for associations between sedentary behaviors and depressive symptoms, most coefficients at within- and across-time as well as within-persons and crossover correlations were not significant. The exceptions were three significant coefficients linking: focus persons' depressive symptoms (T1) – focus persons' sedentary behaviors (T3); focus persons' depressive symptoms (T2) – partners' sedentary behaviors (T2); focus persons' depressive symptoms (T2) – partners' sedentary behaviors (T3). There was also a trend ($p = .097$) for an association between partners' sedentary behaviors (T1) and focus persons' depressive symptoms (T2). All significant associations were positive.

Focus persons–partners differences in the average sedentary time were not significant at T1, paired $t(319) = 1.63$, $p = .104$; at T2, paired $t(319) = 1.22$, $p = .223$; and at T3, paired $t(319) = 0.17$, $p = .863$. There was a significant reduction in sedentary time from T1 to T3 among focus persons, $F(1, 319) = 41.68$, $p < .001$, $\eta^2 = 0.146$, Cohen's $d = 0.29$, and among partners, $F(1, 319) = 14.11$, $p < .001$, $\eta^2 = 0.042$, Cohen's $d = 0.18$ (for descriptive statistics see Supplemental Material 1, Table S1). Focus persons reported higher depressive symptoms at T1 than did their partners, paired $t(319) = 2.51$, $p = .013$, Cohen's $d = 0.19$. There was also a reduction of the depressive symptoms from T1 to T3 among focus persons, $F(1, 319) = 54.48$, $p < .001$, $\eta^2 = 0.116$, Cohen's $d = 0.39$, and

among partners, $F(1, 319) = 40.14$, $p < .001$, $\eta^2 = 0.112$, Cohen's $d = 0.33$ (for descriptive statistics see Supplemental Material 1, Table S1).

3.2. Findings for the dyadic 'sedentary behaviors → depressive symptoms → sedentary behaviors' model

The hypothesized model, calculated for $N = 320$ dyads, had an acceptable fit, with $\chi^2(6) = 12.70$, $p = .048$, $\chi^2/df = 2.116$, NFI = 0.981, CFI = 0.989, RMSEA = 0.059 (90% CI [0.005, 0.105]). The variables in the model explained 46.3% of variance in focus persons' sedentary behaviors (T3) and 42.0% of partners' sedentary behaviors (T3). For associations between the independent variables (T1), mediators (T2), and the dependent variables (T3) see Fig. 1 and Table 2. The values of covariance coefficients are presented in Supplemental Material 1 (Table S3). To control for the potential confounding effects of physical activity, the associations between focus persons' and partners' moderate-to-vigorous physical activity (T1) and the respective independent and mediator variables in the model were accounted for.

The analysis of the hypothesized model showed one simple indirect effect (see Supplemental Material 1, Table S4). Longer sedentary time among partners (T1) was related to higher levels of symptoms of depression among focus persons (T2), which in turn predicted higher sedentary behaviors among partners (T3) (see Table 2). The indirect effect coefficient was significant, $b = 0.010$, $SE = 0.007$, 95% CI [0.000, 0.032], $p = .034$. Additionally, three direct effects were observed. Higher T1 levels of sedentary behaviors among focus persons were associated with higher levels of partners' sedentary behaviors at T3. T1-sedentary behaviors among focus persons were positively associated with their sedentary behaviors at T3. Likewise, partners' sedentary behaviors at T1 were positively associated with their sedentary time at T3.

The sensitivity analysis, controlling for sociodemographic variables (T1), such as gender, age, education, perceived economic status among focus persons and partners, a diagnosis of chronic illness among both focus persons and partners (1 = with a chronic illness vs. 0 = no chronic illness), the type of relationship (1 = romantic vs. 0 = other), and the effects of the experimental group assignment, indicated a pattern of direct and indirect effects similar to those obtained in the hypothesized model (Supplemental Material 1, Tables S5–7). Thus, the robustness of the findings was confirmed. The indirect effects obtained in the total sample were also significant ($p = .035$) in the sensitivity analyses (Supplemental Material 1, Table S6).

Table 2
Direct effects in the 'sedentary behaviors → depressive symptoms → sedentary behaviors' dyadic mediation model.

Variables in the model and hypothesized associations	*B*	*SE*	β	*p*
Sedentary Behaviors (FP, T1) → Depression (FP, T2)	−0.004	0.003	−.077	.172
Sedentary Behaviors (FP, T1) → Depression (P, T2)	−0.002	0.002	−.055	.335
Sedentary Behaviors (FP, T1) → Sedentary Behaviors (FP, T3)	**0.668**	**0.042**	**.672**	**<.001**
Sedentary Behaviors (FP, T1) → Sedentary Behaviors (P, T3)	**0.096**	**0.044**	**.095**	**.028**
Sedentary Behaviors (P, T1) → Depression (FP, T2)	**0.006**	**0.003**	**.124**	**.029**
Sedentary Behaviors (P, T1) → Depression (P, T2)	−0.002	0.002	−.065	.225
Sedentary Behaviors (P, T1) → Sedentary Behaviors (FP, T3)	0.040	0.039	.044	.298
Sedentary Behaviors (P, T1) → Sedentary Behaviors (P, T3)	**0.568**	**0.041**	**.608**	**<.001**
Depression (FP, T2) → Sedentary Behaviors (FP, T3)	0.979	0.885	.047	.269
Depression (FP, T2) → Sedentary Behaviors (P, T3)	**1.887**	**0.928**	**.090**	**.042**
Depression (P, T2) → Sedentary Behaviors (FP, T3)	1.499	1.038	.061	.149
Depression (P, T2) → Sedentary Behaviors (P, T3)	0.442	1.103	.018	.689

Note. T1 = Time 1, baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1; FP = Focus Person; P = Partner; Depression = depressive symptoms; Significant coefficients are marked in bold.

3.3. Findings for the dyadic 'depressive symptoms → sedentary behaviors → depressive symptoms' model

The hypothesized model, calculated for $N = 320$ dyads, had an acceptable fit, with $\chi^2(8) = 17.73$, $p = .023$, $\chi^2/df = 2.117$, NFI = 0.956, CFI = 0.974, RMSEA = 0.062 (90% CI [0.022, 0.101]). The variables in the model explained 41.6% of variance of focus persons' depressive symptoms (T3) and 33.0% of partners' depressive symptoms (T3). For associations between the independent variables (T1), mediators (T2), and the dependent variables (T3), see Fig. 2 and Table 3. The values of covariance coefficients are presented in Supplemental Material 1 (Table S8). To control for the potential confounding effect of physical activity, the associations between focus persons' and partners' moderate-to-vigorous physical activity (T1) and the respective

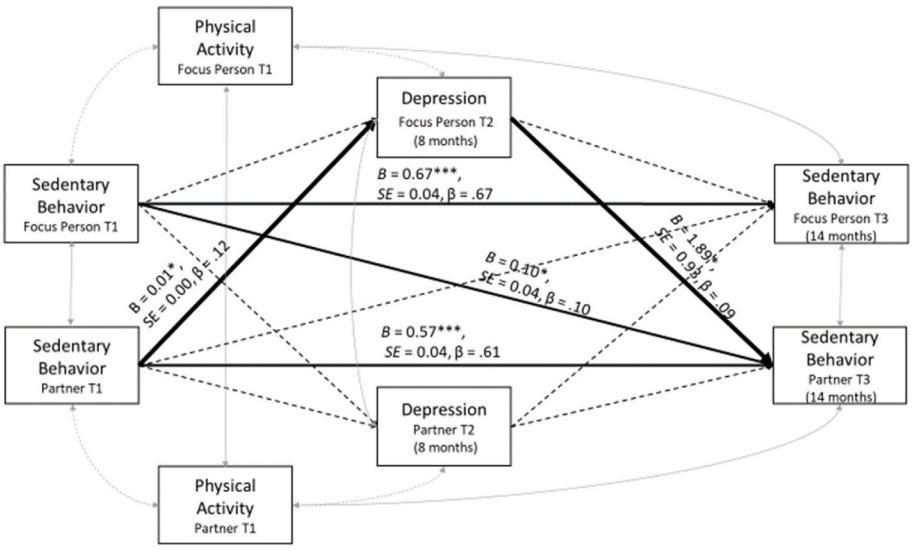

Fig. 1. Results of Path Analysis for the 'Sedentary Behaviors → Depressive Symptoms → Sedentary Behaviors' Dyadic Mediation Model
Note. $^{**}p < .01$; $^{*}p < .05$. Dashed lines represent non-significant paths. Solid lines represent significant paths. Bold solid lines represent significant indirect effects. Black lines represent direct effects, grey lines represent covariances. Residuals of indicators of depressive symptoms at T2 and indicators of sedentary behaviors at T3 were allowed to covary. Depression = depressive symptoms; Physical activity = minutes of moderate-to-vigorous physical activity; T1 = Time 1, baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1.

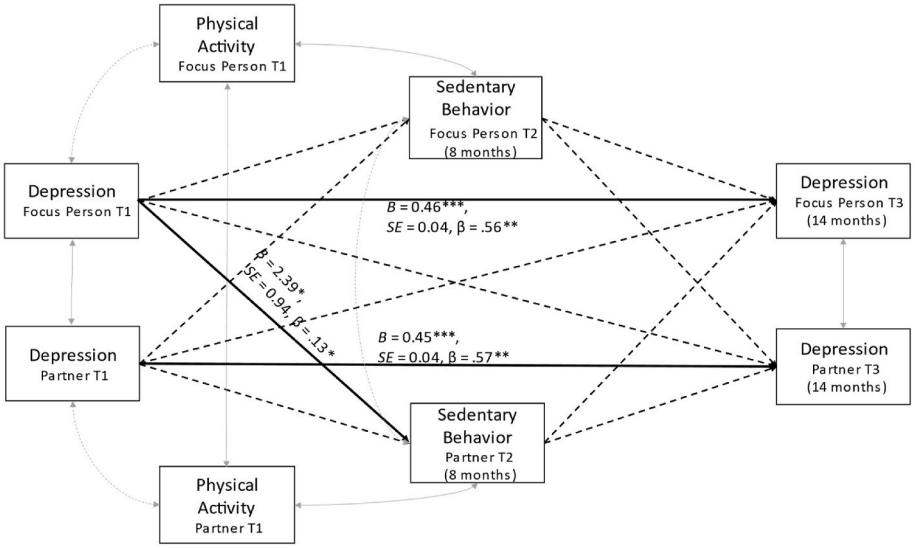

Fig. 2. *Results of Path Analysis for the 'Depressive Symptoms→ Sedentary Behaviors → Depressive Symptoms' Dyadic Mediation Model*
Note. $^{**}p < .01$; $^{*}p < .05$. Dashed lines represent non-significant paths. Solid lines represent significant paths. Black lines direct effects, grey lines represent covariances. Residuals of sedentary behaviors at T2 and depressive symptoms at T3 were allowed to covary. Depression = depressive symptoms; Physical activity = minutes of moderate-to-vigorous physical activity; T1 = Time 1, baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1.

Table 3
Direct effects in the 'depressive symptoms→ sedentary behaviors → depressive symptoms' dyadic mediation model.

Variables in the model and hypothesized associations	*B*	*SE*	β	*p*
Depression (FP, T1) → Sedentary Behaviors (FP, T2)	−0.445	1.057	−.024	.673
Depression (FP, T1) → Sedentary Behaviors (P, T2)	**2.390**	**0.944**	**.131**	**.011**
Depression (FP, T1) → Depression (FP, T3)	**0.463**	**0.039**	**.562**	**<.001**
Depression (FP, T1) → Depression (P, T3)	−0.014	0.035	−.019	.689
Depression (P, T1) → Sedentary Behaviors (FP, T2)	0.842	1.077	.042	.434
Depression (P, T1) → Sedentary Behaviors (P, T2)	−1.777	1.086	−.091	.102
Depression (P, T1) → Depression (FP, T3)	0.017	0.041	.019	.685
Depression (P, T1) → Depression (P, T3)	**0.454**	**0.037**	**.572**	**<.001**
Sedentary Behaviors (FP, T2) → Depression (FP, T3)	0.002	0.002	.045	.332
Sedentary Behaviors (FP, T2) → Depression (P, T3)	0.001	0.002	.027	.564
Sedentary Behaviors (P, T2) → Depression (FP, T3)	−0.002	0.002	−.047	.321
Sedentary Behaviors (P, T2) → Depression (P, T3)	−0.001	0.002	−.032	.495

Note. T1 = Time 1, baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1; FP = Focus Person; P = Partner; Depression = depressive symptoms; Significant coefficients are marked in bold.

independent and mediator variables were accounted for in the hypothesized model.

No significant indirect effects were found (see Supplemental Material 1, Table S9). Higher levels of depressive symptoms among focus persons (T1) were directly related to longer sedentary time among partners (T2). Levels of depressive symptoms (T1) among focus persons were positively associated with their depressive symptoms at T3. Likewise, higher levels of depressive symptoms (T1) among partners were associated with higher symptoms among partners at T3.

The sensitivity analysis, controlling for gender, age, education, perceived economic status among focus persons and partners, having a chronic illness among focus persons and partners (1 = with a chronic illness vs. 0 = no reported illness) the type of relationship (1 = romantic vs. 0 = other), and the effects of the experimental group assignment, indicated a pattern of direct effects similar to those obtained in the hypothesized model (Supplemental Material 1, Tables S10–12). Thus, the robustness of the findings was confirmed.

4. Discussion

This study is among the first testing longitudinal associations between accelerometer-measured sedentary behaviors and depressive symptoms in dyads. It is further novel in examining these effects in a vulnerable population of focus persons who were not sufficiently active, who intended to reduce their sedentary behaviors or increase physical activity, and were likely to have overweight/obesity, cardiovascular disease, or other chronic illness. Path analyses indicated that besides effects indicating time stability of sedentary behaviors and depressive symptoms in dyads, all other significant time-lagged direct effects were crossover, that is from one person to another. Additionally, three of these time-lagged direct effects represent between-construct associations: focus persons' depressive symptoms (T1) → partners' sedentary behaviors (T2); partners' sedentary behaviors (T1) → focus persons' depression (T2); and focus persons' depression (T2) → partners' sedentary behaviors (T3). The fourth significant direct time-lagged effect linked focus persons' sedentary behaviors (T1) and partners' sedentary behaviors (T3). These effects were obtained in a study spanning 14 months, accounting for dyadic interdependency and confounding effects of physical activity, and further confirmed when controlling for sociodemographic covariates.

Our results are consistent with some assumptions made in the framework for investigating dyadic relationship processes and health (Pietromonaco et al., 2013). This framework suggests that health behaviors and affective outcomes in one dyad member are related to health behaviors and affective outcomes in the other member of the dyad (Pietromonaco et al., 2013). Future research may test the potential underlying mechanisms, involving social control and social support strategies (see Huelsnitz et al., 2022) or relationship satisfaction (see Pietromonaco et al., 2013). Shared social networks and physical environment may also have led to a 'dyadic convergence' in affective responses and health behaviors (Meyler et al., 2007). Our findings also extend previous studies linking sedentary behaviors and depression at the within-individual level (Huang et al., 2020; Saunders et al., 2020; Zhang et al., 2022), and go beyond crossover research testing links between maternal depression/negative affect and their child's sedentary behaviors (Yang et al., 2020).

The study showed consistent time-lagged positive associations between focus persons' depressive symptoms and partners' sedentary behaviors, found for T1→T2 and for T2→T3 associations. The opposite associations, from partners' depressive symptoms to focus persons' sedentary behaviors, were not significant. This may be explained by the specificity of the enrolled dyads. Focus persons had significantly higher

levels of depressive symptoms, and were more likely to have overweight/obesity or to be diagnosed with a chronic illness (e.g., cardiovascular disease, type-2 diabetes). A previous report using this dataset indicated that focus persons and partners had high levels of satisfaction with this dyadic relationship (Siwa et al., 2022). In line with the models proposed by Huelsnitz et al. (2022) and Pietromonaco et al. (2013), it seems plausible that in satisfied dyads people may engage in behaviors that indicate their emotional support, companionship, or compassion, to show synchrony with their partner's affective states, indicate their own commitment, and secure the partner's engagement with the relationship. Compared to partners, focus persons in our study reported higher depressive symptoms, and lower overall activation (slowing down accompanied by tiredness, which is one of the symptoms of depression). Their partners, who observed focus persons' depressive symptoms, might have reacted with compassion and emotional support. Reflecting focus persons' lowered behavioral activation, partners might have shown support and compassion by spending time together while sitting with a partner rather than engaging in more physical activity. Compared to focus persons, partners enrolled in our study reported lower levels of depressive symptoms and were less likely to have chronic illness or obesity (compared to focus persons). Thus, partners might have been taking up a role of a support provider, showing support and compassion to focus persons, and more likely to synchronize their sedentary behaviors with focus persons' low activation.

The findings also indicated that longer sedentary time among partners (T1) was associated with higher depressive symptoms at follow-up (T2) in focus persons. Spending more sedentary time together may indicate that dyads engaged in less social interactions with others, thus reducing the size of social support networks for both members of a dyad. Such changes in social network may increase the risk of depression (Huang et al., 2020). Depressive symptoms may be more likely to occur in persons who are more vulnerable due to a presence of other risk factors for depression, such as a chronic illness or obesity (Moazzami et al., 2019), which were more prevalent amongfocus persons than among partners enrolled in our study. Thus, our study showed a link from partners' sedentary behaviors to higher depressive symptoms in focus persons, who were more vulnerable to depression. The opposite association, linking sedentary behaviors of focus persons with subsequent higher levels of depressive symptoms among partners was not significant in our study, which may be due to a lower prevalence of other risk factors for depression, such as obesity, cardiovascular diseases, and type-2 diabetes.

Concluding, the observed direct effects and the significant indirect effect found in our study provide some support for a vicious cycle between sedentary behaviors and depression, hypothesized by Hallgren et al. (2020). To date, such models were limited to within-individual links (Hallgren et al., 2020). Our study shows that this vicious cycle may cross over in dyads in which the focus person has higher depressive symptoms at the baseline and/or is more likely to demonstrate other risk factors for depression, and the partner takes a role of 'supporting person'. Such roles were the inclusion criteria for our study and were further enhanced by the study procedures, where one person was selected as the key focus person for behavior change process. In such dyads, longer sedentary time among partners (T1) may increase the likelihood of depressive symptoms in focus persons (T2), as they are more likely to be at risk for depression due to other risk factors. Higher levels of depressive symptoms (T2) may in turn increase the likelihood of engaging in sedentary behaviors among partners (T3) who observe focus persons' depressive symptoms and engage in synchronized sedentary behaviors while expressing compassion and supportive behaviors (i.e., sit together and support the focus person). It should be noted that we did not find a significant link between partners' sedentary behaviors (T2) and subsequent depressive symptoms among focus persons (T3). The lack of significant associations at these time points may result from an over-time decline of average levels and variability of sedentary behaviors among partners, which was probably induced by the education program delivered to dyads over the initial 2 months of the study. The changes in sedentary time might have reduced the likelihood of observing the associations between partners' sedentary behaviors (T2) and focus persons' depressive symptoms at the later stages of the study (T3).

The effect sizes obtained in our study were mostly weak, therefore their clinical significance is unclear and practice implications cannot be made at this point. Future experimental studies are needed to clarify the clinical meaningfulness of the effect sizes observed in our study. Such research could test if interventions targeting a reduction of sedentary behaviors among partners of people at risk for depression may result in lowering sitting time among partners, but also in a crossover effect, involving a reduction of depressive symptoms among the focus persons. Our findings may have some clinical implications. Behavior change programs and interventions aimed at a reduction of depressive symptoms or prevention of depression among at-risk groups are usually delivered in an individual/group format, involving only individuals with symptoms/at risk. Although further evidence is needed, it may be assumed that having partners involved in such programs and adding intervention components targeting a reduction of sedentary behaviors among partners may enhance the efficacy of the prevention or treatment of depression among people who have a chronic illness and/or do not meet the physical activity recommendations.

The study has several limitations. The majority of participants were people with higher education and medium or higher economic status, which limits any generalizations. Although sensitivity analyses indicated that the associations obtained in the hypothesized models were similar after controlling for the type of dyad (romantic vs. other) and the assignment to the experimental condition, moderating effects of the intervention or the type of relationship on the mediators/dependent variables are possible. Accelerometers were used to capture sedentary behaviors, whereas more preferable devices would involve instruments such as ActivPAL, allowing for a better differentiation between sitting and standing. Due to accelerometer-based measurement we were unable to distinguish between different types of sedentary behaviors, for example 'mentally passive' sedentary activities such as watching TV, and 'mentally active' sedentary behaviors such as reading a book (Hallgren et al., 2020). Similar to the majority of previous research, our sample was drawn from a general population (Hallgren et al., 2020). Therefore, the overall levels of depressive symptoms were mild. This may reduce the likelihood of observing significant effects. Generalizations to clinical samples, consisting of people with, for example, a diagnosed major depressive episode, cannot be made. Future studies may need to use additional measurement points spanning a shorter time period to provide better insights into dyadic processes linking sedentary behaviors and depressive symptoms.

Our study is among the first to provide evidence for crossover (i.e., from one person to another) effects for sedentary behaviors and depressive symptoms. The observed indirect effects, providing partial support for a vicious cycle of sedentary behaviors and depressive symptoms, were found in the context of specific dyads enrolled in our study. The associations were obtained in dyads participating in an intervention to reduce sedentary behaviors and increase physical activity, with focus persons reporting higher levels of depressive symptoms than partners and, additionally having a higher risk for depression due to the presence of other risk factors such as obesity, cardiovascular disease, or type-2 diabetes. Partners, in turn, were accompanying and supporting the focus persons in the process of changing their lifestyles. Initial levels of sedentary behaviors among partners (T1) predicted a higher level of depressive symptoms among focus persons (T2), which in turn was associated with more sedentary time among partners (T3). Hypothetical mechanisms explaining these associations require further investigation.

Author note

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data are available at Open Science Framework https://osf.io/5yrkn/

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.mhpa.2022.100501.

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Associations Between Depressive Symptoms and Sedentary Behaviors in Parent-Child Dyads: Longitudinal Effects Within- and Across Individuals

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Abstract:	Aims : Using cross-lagged panel analysis, this study tested the associations between sedentary behaviors and depressive symptoms among dyads of parents and their 9-15-year-old children. Within-individual and across-individuals effects were investigated. Methods: Data from 203 dyads were collected at Time 1 (T1; baseline), Time 2 (T2; 8-month follow-up), and Time 3 (T3; 14-month follow-up). Parents/legal guardians were mostly women (86.7%), aged 29-66 years. Depressive symptoms were assessed with the Patient Health Questionnaire-9 and sedentary time was measured with GT3X-BT accelerometers. Between T1 and T2, all dyads were enrolled in a healthy lifestyle education program, with one aim, among others, of enhancing awareness of sedentary behaviors and the effects of sedentary behaviors on mental health. Results : In children, more sedentary time at T1 was associated with more depressive symptoms at T2. Depressive symptoms at T1 were related to more sedentary time at T2. Only one across-individuals indirect effect was found, linking more depressive symptoms among children at T1, with more sedentary time among children at T2, and, in turn with more parental depressive symptoms at T3. Conclusion: Children with higher depressive symptoms at T1 may struggle to change their sedentary behaviors and, consequently, engage in more sedentary behaviors at follow-ups. Higher levels of sedentary time among children may be observed by parents, who may perceive this unfavorable behavioral pattern as a result of their own inefficiency/failure of parental efforts to change children's behaviors, which in turn may be related to higher levels of depressive symptoms among parents.
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Associations Between Depressive Symptoms and Sedentary Behaviors in Parent-Child Dyads: Longitudinal Effects Within- and Across Individuals

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Abstract

Aims*:* Using cross-lagged panel analysis, this study tested the associations between sedentary behaviors and depressive symptoms among dyads of parents and their 9-15-year-old children. Within-individual and across-individuals effects were investigated.

Methods: Data from 203 dyads were collected at Time 1 (T1; baseline), Time 2 (T2; 8-month follow-up), and Time 3 (T3; 14-month follow-up). Parents/legal guardians were mostly women (86.7%), aged 29-66 years. Depressive symptoms were assessed with the Patient Health Questionnaire-9 and sedentary time was measured with GT3X-BT accelerometers. Between T1 and T2, all dyads were enrolled in a healthy lifestyle education program, with one aim, among others, of enhancing awareness of sedentary behaviors and the effects of sedentary behaviors on mental health.

Results*:* In children, more sedentary time at T1 was associated with more depressive symptoms at T2. Depressive symptoms at T1 were related to more sedentary time at T2. Only one across-individuals indirect effect was found, linking more depressive symptoms among children at T1, with more sedentary time among children at T2, and, in turn with more parental depressive symptoms at T3.

Conclusion: Children with higher depressive symptoms at T1 may struggle to change their sedentary behaviors and, consequently, engage in more sedentary behaviors at follow-ups. Higher levels of sedentary time among children may be observed by parents, who may perceive this unfavorable behavioral pattern as a result of their own inefficiency/failure of parental efforts to change children's behaviors, which in turn may be related to higher levels of depressive symptoms among parents.

Keywords; Sedentary behavior; Parent-child dyads, Depression; Cross-lagged panel

Throughout the waking hours, adults and adolescents devote over eight hours of their waking time to various sedentary behaviors involving sitting or reclining and characterized by an energy expenditure of ≤ 1.5 metabolic equivalents (Bauman et al., 2018; Dalene et al., 2022; Tremblay et al., 2017). Sedentary behaviors have adverse impacts on physical health, mental well-being, and overall quality of life that persist throughout adolescence and adulthood (Boberska et al., 2018; Saunders et al., 2017). Recognizing the factors influencing sedentary behaviors in both adolescents and adults is essential for planning interventions and policies that may effectively prevent mental health issues, such as depression, affecting 7 % to 20 % of the population during their lifetime (Lim et al., 2019). Meta-analyses have linked sedentary behaviors with an increased likelihood of subsequent depression among adults and adolescents (for a meta-analysis see: Huang et al., 2020; Zhang et al. 2022). Recent accelerometer-based longitudinal studies confirmed that adolescents who have high average sedentary time when they are 12, 14, and 16 years old, are at a higher risk for depression, compared to those young people who spent less time sitting in adolescence (Kandola et al., 2020).

To date, the main focus of research linking sedentary behaviors and depression has been the *within-individual association* of sedentary behaviors and subsequent depressive symptoms (e.g., Kandola et al., 2020), which may be observed among both adolescents and adults. The hypothesized within-individual associations are primarily based on biological and neurobiological models and research that proposes links between sedentary behaviors and depressive symptoms through heightened inflammatory markers, and related unfavorable changes in neurobiological pathways (Hamer & Smith, 2023; Zou et al., 2024). Evidence-based immune and neurobiological models suggest a bidirectional relationship, where sedentary

behaviors may increase the likelihood of elevated depressive symptoms, and vice versa (Hallgren et al., 2020). High levels of depressive symptoms also boost the likelihood of replacing physical activity (PA) with more sedentary time, which in turn may reduce the possibility of recovery or increase the risk of a relapse/recurrence of depression (Huang et al., 2020).

Recent research has also proposed an *across-individuals* perspective, which assumes that social learning processes and shared environment may result in associations between depressive symptoms among parents and depressive symptoms among their adolescent children (for a review, see Wickersham et al., 2020). Shared environment and social learning processes may also explain the associations between parents' sedentary time and adolescents' sedentary time (Cabanas-Sanchez et al., 2020). However, the empirical test of across-individuals associations between sedentary behaviors and depression in parent-adolescent dyads is missing. The present study aims to fill this gap. Additionally, the study follows recent research by Siwa et al. (2023), investigating within-individual and across-individuals relationships between sedentary behaviors and depression associations among patient-partner dyads (consisting of two adults). Siwa et al. (2023) found significant time-lagged across-individuals effects with patients' depressive symptoms (T1) predicting partners' sedentary time (T2) and partners' sedentary time (T1) predicting patients' depressive symptoms (T2). The present study aims to investigate if the across-individuals patterns, indicating that more sedentary time of one dyadic partner predicts more depressive symptoms for the other dyadic partner, may also emerge in dyads of parents and their adolescent children.

Recent theoretical developments highlight the importance of dyadic and within-family contexts of health behaviors and other health (or mental health) indicators. For example, the shared resources hypothesis (Mayler et al., 2007) and the frameworks for investigating dyadic

relationship processes (Pietromonaco et al., 2013) propose interrelatedness between health behaviors and affective outcomes within-individuals and potential across-individuals effects. However, these two models (Mayler et al., 2007; Pietromonaco et al., 2013) were developed, to describe the processes taking place in romantic couples of adult-adult dyads, where the power and resources are typically contributed and utilized in a more symmetrical manner, than in dyads consisting of parents and their children.

Several mechanisms may explain across-individuals associations between sedentary behaviors and depressive symptoms in parent-child dyads. One of the potential pathways involves high levels of parental stress that are followed by an increase in sedentary behaviors in children (for a review, see O'Connor et al., 2017). Parental stress may be followed by negative affective states or depressive symptoms; in turn, parents' depression may also increase the likelihood of problematic parenting, or passive parenting strategies, which may increase the likelihood of negative behavioral outcomes in children (Goodman et al., 2020). For example, Yang et al. (2020) and Dutton et al. (2021) found that higher negative emotions of mothers and higher maternal stress predicted more sedentary time among their 8-12-year-old children.

Adolescent children, navigating a developmental stage marked by heightened independence (Koepke & Denissen, 2012), may perceive even subtle parental efforts to control their behaviors as constraints on their freedom of choice regarding behavior (Brehm, 1966; Rosenberg & Siegel, 2018), which may be a source of stress for their parents. To emphasize their independence, adolescents may demonstrate resistance to parenting practices (Koepke & Denissen, 2012), including those aiming to reduce adolescents' sedentary behaviors. Additionally, parent-adolescent relationships exhibit asymmetrical dynamics (as the relationship in parent-young child dyads), largely due to the parent's dual role as a gatekeeper of many

behaviors of adolescents and their caregiver figure (Collins, 1995; Horodyska et al., 2019). Parents may feel the obligation to influence adolescents' behaviors, but they may also perceive that parenting strategies (that were effective in early and middle childhood) are no longer linked to the expected changes in adolescents' sedentary behaviors (Sanders et al., 2017). The perceived ineffectiveness may be expected to exacerbate stress and negative mood. On the other hand, parent-delivered interventions, aiming at teaching parents to manage adolescent behaviors, result in a reduction of sedentary time among adolescents (for review, see Champion et al., 2022).

In the context of parent-child research, there is some evidence for the opposite pattern, namely the "lower stress/higher positive affect -> more sedentary time" hypothesis. Within-individual analyses conducted among mothers of 8-12-year-old children indicated that a higher level of positive emotions of mothers predicted more time spent on sedentary behaviors by mothers (Yang et al., 2020). This may be explained by an assumption that lower stress/more relaxation among parents is followed by relaxing activities, involving sitting or reclining (see also Yang et al., 2020). In sum, the order in which depression and sedentary behaviors may be chained at within-individual and across-individuals levels in parent-child dyads is unclear.

Moreover, it should be stressed that the associations between depressive symptoms and sedentary behaviors have often been established in research using either cross-sectional (Goodman et al., 2020) and/or within-individual (Hallgren et al., 2020; Hamer & Smith, 2023; Zou et al., 2024) approaches, as well as the use of self-report rather than accelerometers to assess sedentary time (Zhang et al., 2022). Furthermore, research in parent-child dyads has tended to focus on negative affect or stress rather than on symptoms of depression (O'Connor et al., 2017; Yang et al., 2020). Finally, to the best of our knowledge, there is no empirical evidence for the order in which sedentary time and depressive symptoms are linked in parent-child dyads.

Study Aims

This study aimed to explore the time-lagged direct and indirect (mediation) effects, linking depressive symptoms and sedentary time at within-individual level, but also across-individuals. In particular, two hypothetical models were used to explore within-individual effects and across-individuals effects (from one person to another) in parent-child dyads, assuming that: (1) parental and children's sedentary time (Time 1; T1) were expected to predict depressive symptoms (measured at Time 2, T2; 8 months after T1) of both parents and children. Depressive symptoms (T2) were in turn expected to predict sedentary time, assessed at Time 3 (T3, 14 months after T1); and (2) the levels of depressive symptoms assessed among parents and children at T1 were expected to predict sedentary time (T2) of parents and children. Sedentary time (T2) in turn was expected to predict depressive symptoms (T3) of parents and children.

These research questions are parallel to those examined by Siwa et al. (2023) among adult-adult dyads. In the present study we did not hypothesize a specific direction in the association between depressive symptoms and sedentary time due to mixed results of existing research (Hallgren et al., 2020; Hamer & Smith, 2023; Yang et al., 2020; Zou et al., 2024).

Because moderate-to-vigorous physical activity constitutes a confounding variable when investigating associations between depressive symptoms and sedentary time (Blough & Loprinzi, 2018), moderate-to-vigorous physical activity at T1 was controlled in all analyses.

Method

This study reports secondary findings derived from a registered randomized controlled trial (ClinicalTrials.gov, #NCT02713438). The primary aim of the registered trial was to explore the impacts of three types of planning interventions delivered to parent-child dyads, compared to a control condition (Kulis et al., 2024; Szczuka et al., 2024). Across experimental and control

conditions, all parents and their children participated in identical education sessions. The sessions covered definitions and patterns of sedentary behaviors, the health consequences associated with sedentary behaviors, and strategies to interrupt sedentary bouts and minimize overall sedentary time. Tailored examples of methods to reduce sedentary behaviors were provided based on the participants' age (i.e., offering children tips on how to reduce sedentary behaviors while at school [Kulis et al., 2024; Szczuka et al., 2024]). Physical activity was the main outcome in the respective trial, sedentary time was the secondary outcome (Kulis et al., 2024; Szczuka et al., 2024), with analyses indicating that the physical activity planning interventions did not influence sedentary time at T3, in neither children nor their parents (Szczuka et al., 2024).

The present study utilized data collected at three measurement points at which accelerometer-based data were collected: Time 1 (T1; baseline); Time 2 (T2; 8 months after baseline), and Time 3 (T3; 14 months after baseline). Each measurement point consisted of self-reported depressive symptoms and was followed by six days of accelerometer-based measurement. Data were collected individually (each member of the dyad completed questionnaires separately) during face-to-face meetings of each dyad with an experimenter.

The inclusion criteria were: (1) children aged between 10 and 14 years old, corresponding to students in the 4th to 8th grade of primary school; however, to mitigate potential feelings of exclusion among children in the same school grade, participants who were either 9 years old (n = 11) or 15 years old (n = 2) at the initial assessment were also included; (2) child physical activity levels before enrollment were reported by parents to be below the thresholds specified by the World Health Organization (WHO; 2010, 2020); (3) both children and parents expressed an intention to increase their physical activity, as declared during the recruitment process. Due to

the focus on depressive symptoms, the present study used an additional exclusion criterion, which referred to a lack of any symptoms of depression at T1 among both members of the dyad.

Data collection took place between February 2016 and March 2022 in 18 urban locations and nine rural locations in South-Western Poland. Recruitment occurred during parent-teacher meetings in schools, through social media channels, or on the websites of non-governmental organizations or municipalities. Parents who spent most time with their adolescent children and were the main persons responsible for the adolescents' sedentary behaviors, exercise, and nutrition were invited to participate alongside their children. Potential participants were briefed on the study's objectives and procedures. Following a review of the study information materials, participants underwent eligibility screening. Informed consent was sought from both parents and adolescents for study participation; additionally, parental consent for their child's participation was obtained. The study received approval from the Ethics Committee at the institution of the first author. Participants did not receive financial compensation for their involvement; instead, they were given a thank-you gift (valued between 5-10 EUR) after each measurement.

Participants

In total, 463 parents and 451 children underwent eligibility screening, with 261 parents and 204 children either not meeting the inclusion criteria or opting not to participate in the study. The initial sample included $N = 247$ dyads, of which 44 reported no symptoms of depression at all in either parent or adolescent at T1. The final analyzed sample included $N = 203$ parent-child dyads. T3 assessment (14-month follow-up) was completed by $n = 129$ dyads, indicating a dropout rate of 36.5 %.

At T1, parents (or legal guardians) were mostly women (86.7%), aged from 29 to 66 years ($M = 40.85$ years; $SD = 4.77$). For 59.6 % of parents overweight or obesity was observed,

while 34.0 % had normal body weight, and 6.4 % were underweight. A significant proportion of parents (72.8%) had completed higher education, 24.7 % held a high school or vocational diploma, and 2.5 % reported primary education. Regarding economic status, 48.0 % of parents perceived it as similar to the average family in the country, 44.6 % reported that their economic status was above average, and 7.4 % described it as worse than the average family in the country.

Children (48.8% girls) were between 9 and 15 years old (M = 11.41 years; SD = 1.26). The 9-year-olds (n = 10) who took part in the study represented advanced social and cognitive development (i.e., school maturity evaluated in enrollment in 1st grade) and they initiated their formal education at an earlier age compared to their peers. Among children, 54.7 % fell within the normal body weight range (according to BMI cut-offs; Cole & Lobstein, 2012), 42.3 % were categorized as overweight or obese, and 3.0 % were underweight. At T1, 85.6 % of parents declared that they exercised for less than 150 minutes per week, indicating non-compliance with physical activity recommendations (WHO, 2010, 2020).

Measures

Means, standard deviations, and internal consistency coefficients are presented in Supplemental Material 1, Table S1.

Sedentary Behaviors (T1, T2, and T3)

Sedentary time data were collected using hip-worn ActiGraph GT3X-BT accelerometers. Children and parents were instructed on the use of the device for six consecutive days, during their waking hours. To be included in analyses, data from an accelerometer had to be recorded for ≥ 8 hours per day, over ≥ 3 days during the respective measurement period (Prescott et al., 2020). The scoring of data involved the application of the Freedson VM3 algorithm (Sasaki et al., 2011) for parents, and the Evenson et al. (2008) algorithm for children, within Actilife

software. Non-wear time was determined using an epoch-based algorithm based on Choi et al. (2011). We utilized 10-second epochs to enhance the distinction between sedentary behaviors and physical activity (Quante et al., 2015). Sedentary time was computed as the average minutes of sedentary behaviors per hour of wear time. Data from the first valid wear day at T1 were excluded to mitigate initial elevation effects in the analysis.

Depressive Symptoms (T1, T2, and T3)

The Patient Health Questionnaire-9 (PHQ-9; Kroenke et al., 2001) was used to assess depressive symptoms. Responses on the PHQ-9 range reflect the frequency of each symptom over the past two weeks (0 - *not at all*, 1 - *several days*, 2 - *more than half the days*, 3 - *nearly every day*). Scores between 5 and 9 indicate mild depression, scores of 10-14 suggest moderate depression, 15-19 indicate moderately severe depression and scores ≥ 20 represent severe depression (Kroenke et al., 2001). Among the children participating in the study, 41.9 % indicated mild depressive symptoms, 12.8 % moderate depressive symptoms, 6.9 % moderately severe depressive symptoms, whereas 0.5 % demonstrated severe depression. Among parents, 36% indicated mild depressive symptoms, 20.2 % moderate depressive symptoms, and 5.9 % moderately severe depressive symptoms, with none demonstrating severe depressive symptoms. The internal consistency was good, with the values of Cronbach's αs at T1, T2, and T3 ranging between .79 and .89 for both parents and children.

Control Variables

The average minutes of moderate-to-vigorous physical activity per hour of wear time for both parents and children at T1 were assessed using accelerometers (ActiGraph wGT3X-BT). Valid data were defined as three to six consecutive days with a minimum of eight hours per day of accelerometer wear on the right hip, following the criteria outlined by Prescott et al. (2020).

Moderate-to-vigorous physical activity was calculated in minutes per day using the algorithm proposed by Sasaki et al. (2011). Univariate outliers ($z > |3.29|$) were winsorized, adjusting values to one unit lower or higher than the next highest or lowest value in the distribution, respectively. Data recorded during the initial valid wear day at T1 were excluded.

Sociodemographic covariates included: (1) parental and child age; (2) parental and child gender; (3) parental education (coded as elementary = 1, vocational [below high school level] = 2, high school = 3, post-secondary = 4, BA degree = 5, MA/MSc degree or higher = 6); and (4) parental self-reported economic status, rated on a scale ranging from 1 *(much below the average family in Poland*) to 5 (*much above the average family in Poland*).

Data Analysis

The G*Power calculator, simulating a multiple regression model, was employed for post-hoc sample size calculations. Based on assumed small effect sizes (approximately f = .08), aligned with previous dyadic longitudinal research (Siwa et al, 2023), a power of .90, a Type I error rate of .05, and considering confounding effects of physical activity, the determined sample size was approximately 200 dyads.

Data analyses were conducted using IBM SPSS and AMOS versions 28. Path analyses were carried out using maximum likelihood estimation. The two hypothesized models operated under the assumption that parents and their children were distinguishable. These models accounted for three measurement points, with the independent, mediator, and dependent variables assessed at separate time points while controlling for the T1-level of the dependent variable. Various indices assessing model-data fit were employed. For the comparative fit index (CFI) and the normed fit index (NFI), a threshold of ≥ .95, indicating favorable model-data fit, was applied (Byrne, 2016). A threshold of ≤ .08 for the root mean square error of approximation

(RMSEA) was utilized (Byrne, 2016). The evaluation of indirect effects utilized unstandardized effect coefficients, computed through 10,000 bootstraps with a 95 % confidence interval. The full information maximum likelihood procedure was employed to address missing data, encompassing cases lost due to dropouts at T2 and T3 (Byrne, 2016). Little's MCAR test suggested nonsystematic patterns in the missing data, Little's $\chi^2 = 439.42$, $p = .432$. Mardia's coefficient of multivariate normality indicated moderately non-normal values, specifically 20.10 for the 'sedentary behaviors → depression → sedentary behaviors' model and 13.70 for the 'depression → sedentary behaviors → depression' model.

Analytic Strategy for the Manifest Mediation Models

The models were estimated following the guidelines for the actor-partner interdependence model with mediators (APIMeMs, Ledermann et al., 2011). These models were manifest and saturated, encompassing associations among the independent, mediator, and dependent variables, along with their corresponding covariances (Ledermann et al., 2011). The indicators of the independent variable at T1, assessed in both parent and child, were assumed to predict T3 indicators of the dependent variables measured in both members of the dyad. This prediction was mediated by variables (T2) assessed in both individuals within the dyad. To address dyadic interdependence, it was assumed that the indicators of independent variables (T1) would covary, and the indicators of the control variable, moderate-to-vigorous physical activity at T1 measured in parent and child, were also assumed to covary. Additionally, the residuals of the mediators (T2) and sedentary behaviors at T3, measured in both individuals within a dyad, were assumed to covary. Furthermore, indicators of moderate-to-vigorous physical activity of parent and child were assumed to covary with the independent, mediator, and dependent variables assessed at the within-individual level.

Rather than employing a single model to assess all mediation hypotheses, we computed two hypothesized mediation models. This approach was chosen to mitigate potential bias associated with multicollinearity and prevent a reduction in analytical power stemming from a high number of parameters in the model, as similarly adopted in other studies (e.g., Banik et al., 2021; Siwa et al., 2023).

Indirect effects were examined, including those where the independent, mediator, and dependent variables were measured in a single person, and those with at least one variable in the sequence 'the independent variable → the mediator → the dependent variable' measured in one person, while at least one variable in this sequence was measured in the other person. Simple indirect effects were calculated using the user-defined estimands function (Amos Development Corporation, 2021; Ledermann et al., 2011).

To ensure the robustness of the findings, sensitivity analyses were conducted. These analyses assessed whether the pattern of associations remained consistent in the hypothesized model and a model that controlled for variables such as age, gender of both parent and child, parental education, and parental reports of economic status. Additionally, the effects of the experimental group assignment (1 = a planning intervention, 0 = control group) on the independent, mediator, and dependent variables were accounted for.

Results

Preliminary Analyses

Attrition analysis suggested that there were no differences in T1 variables assessed in parents and children when data from completers were compared to data of those who dropped out (see Supplemental Material 1). Bivariate correlations among the study variables are presented in Supplemental Material 1, Table S2. Regarding associations among indicators of

depressive symptoms, there were significant within-individual correlations across measurement points. There were significant across-individuals (parent-child) correlations at T1 and T2.

Regarding sedentary time, there were significant positive correlations found within-individual (e.g., children's sedentary time at T1 and T2) and across-individuals (parent-child) correlations, which were observed within measurement points and across measurement points, except for one non-significant association: Children's sedentary time (T1) was unrelated to parental sedentary time at T2.

Regarding associations between sedentary time and depressive symptoms, most cross-sectional and longitudinal correlation coefficients within-individual and across-individuals were not significant. The exceptions were five significant coefficients: children's depressive symptoms (T1) were related to more children's sedentary time at T1, T2, and T3; children's sedentary time (T1) was associated with more children's depressive symptoms (T2); children's depressive symptoms (T3) were associated with more parental sedentary time (T3). A trend for an association (p =.089) was observed for higher levels of sedentary time among children (T2) and more depressive symptoms among parents at T3. All significant associations were positive. Additional correlation analyses indicated a significant association between children's depressive symptoms (T2) and their sedentary time (T3), after the baseline level of children's sedentary time was partialled out (Supplemental Material 1, Table S3) and a trend for an association between parental sedentary time (T2) and depressive symptoms among parents at T3, after the baseline level of parental depressive symptoms were partialled out (Supplemental Material 1, Table S3).

Changes in Sedentary Behaviors and Depressive Symptoms Over Time (Within and Across Individuals)

Children spent significantly more time on sedentary behaviors than their parents at T1, paired $t(203) = 14.37$, $p < .001$, Cohen's $d = 1.01$; at T2, paired $t(202) = 17.79$, $p < .001$, Cohen's $d = 1.25$; and at T3, paired $t(202) = 20.49$, $p < .001$, Cohen's $d = 1.44$. There was a significant reduction in sedentary time from T1 to T3 among children, $F(1, 202) = 17.13$, $p < .001$, $\eta^2 = .078$, and no significant change among parents, $F(1, 202) = 1.09$, $p = .303$, $\eta^2 = .005$ (for descriptive statistics see Supplemental Material 1, Table S1).

Parent-child differences in depressive symptoms were not observed, at neither T1, paired $t(202) = 0.40$, $p = .686$, nor at T2, paired $t(202) = 0.53$, $p = .596$. However, at T3, children reported significantly more depressive symptoms than their parents, paired $t(202) = 2.37$, $p = .019$, Cohen's $d = 0.17$. There was no significant change in depressive symptoms from T1 to T3 among children $F(1, 202) = 3.69$, $p = .056$, $\eta^2 = .018$, but there was a reduction of depressive symptoms from T1 to T3 among parents, $F(1, 202) = 28.44$, $p < .001$, $\eta^2 = .123$ (for descriptive statistics, see Supplemental Material 1, Table S1).

Findings for the Dyadic 'Sedentary Behaviors → Depression → Sedentary Behaviors Model

The hypothesized mediation model with $N = 203$ dyads, had an acceptable fit, with $\chi^2(6) = 12.44$, $p = .053$, $\chi^2/df = 2.073$, NFI = .978, CFI = .988, RMSEA = .073. The variables in the model explained 41.5 % of the variance in children's sedentary time (T3) and 37.5 % of parents' sedentary time (T3). For associations between the independent variables (T1), mediators (T2), and the dependent variables (T3), see Figure 1 and Table 1. For clarity, the values of covariance coefficients are not depicted in Figure 1 but are reported in Supplemental Material 1 (Table S4). To control for the potential confounding effects of physical activity, the associations between

parents' and children's moderate-to-vigorous physical activity (T1) and the respective independent and mediator variables in the model were accounted for.

The analysis of the hypothesized model showed four direct effects. Children's sedentary time at T1 was positively associated with their own depressive symptoms at T2 and their sedentary time at T3. However, children's depressive symptoms at T2 were associated with less sedentary time at T3. Parental sedentary time at T1 was positively associated with their sedentary time at T3. Only one within-individual indirect effect was found, b = - 0.024, SE = 0.014, 95 % CI [-0.065, -0.005], p = .010 (see Supplemental Material 1, Table S5). This effect indicated that higher levels of sedentary time among children (T1) were related to children reporting higher levels of symptoms of depression (T2), which in turn predicted lower levels of sedentary time among children (T3) (see Table 1).

The sensitivity analysis, controlling for sociodemographic variables (T1) such as gender, age, parental education, parental perceptions of economic status, and the effects of the experimental group assignment indicated a pattern of direct and indirect effects similar to those obtained in the hypothesized model (Supplemental Material 1, Tables S6-8). Thus, the robustness of the findings was confirmed. The indirect effects obtained in the total sample were also significant (p = .035) in the sensitivity analyses (Supplemental Material 1, Table S7).

Findings for the Dyadic 'Depression → Sedentary Behaviors → Depression' Model

The hypothesized model, calculated for N = 203 dyads, had an acceptable fit, with $\chi^2(8)$ = 14.10, p = .079, χ^2/df = 1.762, NFI = .956, CFI = .979, RMSEA = .061. The variables in the model explained 27.0 % of the variance of children's depressive symptoms (T3) and 32.1 % of parents' depressive symptoms (T3). For associations between the independent variables (T1), mediators (T2), and the dependent variables (T3), see Figure 2 and Table 2. The values of

covariance coefficients (not displayed in Figure 2, for clarity reasons) are presented in Supplemental Material 1 (Table S9). The associations between parental and children's moderate-to-vigorous physical activity (T1) and the respective independent and mediator variables were accounted for in the hypothesized model.

Four direct effects were observed. Higher levels of depressive symptoms (T1) among children were positively associated with children spending more time sitting at T2 and more depressive symptoms in children at T3. Higher parental depression at T1 was associated with more depressive symptoms among parents (T3). Finally, longer sedentary time among parents at T2 was related to lower levels of depressive symptoms among parents at T3. One significant indirect effect was found (see Supplemental Material 1, Table S10). A higher level of depressive symptoms among children (T1) was related to children's higher sedentary time (T2), which in turn predicted more depressive symptoms among parents (T3) (see Table 2). The indirect effect coefficient was significant, $b = 0.023$, $SE = 0.013$, 95 % CI [0.003, 0.057], $p = .022$.

The sensitivity analysis, controlling for gender, age, parent's education, parent's perceived economic status, and the effects of the experimental group assignment, indicated a pattern of direct effects similar to those obtained in the hypothesized model (Supplemental Material 1, Tables S11-13). Thus, the robustness of the findings was confirmed.

Discussion

This study is among the first to provide insights into time-lagged within-individual and across-individuals associations between depressive symptoms and accelerometer-assessed sedentary time among parents and their 9-15-year-old children. Children's longer sedentary time (at the baseline) predicted more depressive symptoms at the 8-month follow-up, but the reverse order of the associations was also true namely higher children's depressive symptoms at the

baseline were related to more sedentary time among children at the 8-month follow-up. The observed associations may be interpreted as indirectly confirming the immune and neurobiological models suggesting a bidirectional within-individual association between sedentary time and depression (Hallgren et al., 2020; Hamer & Smith, 2023; Zou et al., 2024) or other psychosocial models, suggesting that sedentary time and depressive symptoms are linked together as both may increase social isolation and reduce the overall levels of social interactions (Huang et al., 2020).

The indirect effect analysis indicated that higher levels of sedentary time among children (T2) were linked to more depressive symptoms among parents at T3; however, this effect needs to be considered with caution, as the respective bivariate association was only a statistical trend. If these findings are replicated in future research, the explanations for the links might, for example, include parental awareness of the fact that they failed to support their adolescent children effectively in the process of change of sedentary behaviors (as indicated by relatively high levels of sedentary time among children at T2), and consequently, increased parenting stress or dissatisfaction and/or increased levels of depressive symptoms among parents at T3. As suggested by Sanders et al. (2017), parents observing their adolescent children may feel the obligation to influence adolescents' behaviors and experience reduced own efficacy when applying parenting strategies (that were effective in early and middle childhood), in particular when changes in adolescents' sedentary behaviors are considered.

The findings indicating bidirectional within-individual associations between sedentary time and depressive symptoms should be considered in the context in which the data were collected. Between the baseline and the 8-month follow-up measurements, all parent-child dyads took part in an education program addressing sedentary behavior, ways to replace sedentary time,

and consequences of sedentary behaviors for physical and mental health (Kulis et al., 2024; Szczuka et al., 2024). In other words, participants were triggered to reduce sedentary time. Sitting or reclining is usually a habitual behavior, performed automatically, and thus very difficult to change (Rollo et al., 2016). The present study showed a small reduction in sedentary time among children. At the same time, meta-analyses of longitudinal studies pointed out that sedentary time increases substantially (weighted mean difference for 1 year = 27.9 minutes) among children and adolescents (Kontostoli et al., 2021), whereas self-regulatory skills remain low at ages 10-14, before starting to increase at ages 15 and on (Atherton, 2020). Combining these contextual factors together, it may be acknowledged that 9-15-year-olds participating in the study were in a developmental period during which their self-regulatory skills were limited, they were pressured to change behavior that is hard to change for anybody, and that usually increases during this stage of development. Those who had high levels of sedentary time might have reported more depressive symptoms at the 8-month follow-up because they were asked to handle a difficult task due to the habitual character of the behavior at hand and limited self-regulatory capacity. They were also engaged in this task together with their parents (which is contrary to their developmental needs of individuation). All these factors might have made the behavior change process particularly demanding and frustrating, which might have increased the likelihood of a higher level of depressive symptoms at the 8-month follow-up. The proposed mechanisms remain hypothetical, as self-regulatory skills, habits, and individuation processes were not measured in the present study.

We found one unexpected within-child association, with children reporting lower levels of depressive symptoms at T2 spending more time sitting at T3. This, in turn, may reflect the long-term effects of the education received between T1 and T2, which highlighted the

bidirectional association between depressive symptoms and sedentary behavior. Among others, a reduction of sedentary behaviors was presented in education to alleviate depressive symptoms. Young people who recognized and self-reported low levels of depressive symptoms (T2) might have realized they do not need to put more effort and reduce their sedentary time to change their mood; the awareness that they feel well and have no negative affect could limit children's motivation to reduce sedentary time (e.g., all is well with my mood, therefore I am reluctant to invest more efforts/follow adults' advise; I can afford to sit more). Thus, lower depressive symptoms at post-education (T2) may have been followed by more time spent sitting or reclining at T3. At the same time, we found that children participating in our study indeed reduced sedentary time between T1 and T3. The associations discussed here should be treated with caution, as in the correlation (bivariate) analysis, significant relationships between children's depressive symptoms (T2) and their sedentary time (T3) were observed only after partialling out sedentary time at T1 (see Supplemental Material 1, Table S3). Again, the mechanisms hypothesized here were not investigated. Future studies should investigate whether, among young people with higher levels of depressive symptoms, awareness of the link between sedentary behaviors and depression may lead to a reduction in sedentary time.

The present study suggests that only two effects were observed for the variables assessed among parents. The hypothesized mediation model suggested that more sedentary time among parents at T2 was related to fewer depressive symptoms among parents at T3. This association may be explained by research linking lower parenting stress (and related lower levels of negative affect) with a higher level of relaxation-related behaviors, involving sitting or reclining (Yang et al., 2020). Prior research, however, has tested and confirmed the opposite order of associations, namely lower stress (or higher positive emotions) linked to more sedentary time among mothers

(Yang et al., 2020). Our study provides novel evidence suggesting that parents (mostly mothers) who spent more time on sedentary behaviors at T2 may benefit from sedentary time, as they reported fewer depressive symptoms at T3. It is possible that a low level of parenting stress, along with fewer household chores and parenting duties, allows parents to spend more time sitting (and relaxing), which in turn prompts better well-being and fewer depressive symptoms. The analyzed associations should be treated with caution, as a bivariate association indicated only a statistical trend for the associations between parental sedentary behaviors (T2) and their depressive symptoms at T3, only after depressive symptoms at T1 were partialled out (see Supplemental Material 1, Table S3). Notably, the link between parental depressive symptoms at T1 and sedentary time at T2 was not significant. This may be because T1-T2 period captures the intervention period, where parents were prompted to change their own sedentary time and were also likely to engage in efforts to model and influence their children's behavior (a reduction of sedentary behaviors), which may reduce the likelihood of their own depressive symptoms via physiological pathways but at the same time increase the risk of their children reacting with reactance and resistance to attempts to model child's behavior change (Koepke & Denissen, 2012), thus increasing parental stress and negative emotions. As the levels of parental stress and commitment to household/parenting duties were not controlled in the present study, their effects remain hypothetical and should be further investigated.

Comparing the patterns of associations obtained in the present study with those obtained in research using the same design and methods but enrolling patient-partner dyads (Siwa et al., 2023), different patterns of associations emerged, with none of the direct and indirect effects significant in patient-partner dyads emerging as significant in dyads of parents and their 9-15-year-old children. Parent-child dyads differed from patient-partner dyads (mostly romantic

couples) in many underlying dimensions, such as assigned role/duty of influencer, gate-keeper, and model, responsible for behaviors of the other person in the dyad (strong imbalance in parent-child dyad versus relative equality in patient-partner dyads), the competence of dyadic members (similarly, a lack of balance e.g., in self-regulatory skills in parent-child dyads versus relative equality in adult-adult dyads). These underlying differences and related internal and external pressure to perform the parenting role effectively (Sanders et al., 2017) may influence the patterns of associations between any health behaviors (e.g., healthy diet, smoking) and any emotion-related or well-being outcomes (e.g., distress or positive affect). Unfortunately, much-needed research testing the moderating role of different types of dyads in the dyadic health behavior change process is rare.

The study has several limitations. Most parents involved in the study were people with higher education and medium or higher economic status, thereby constraining generalizability of the findings. In addition, the utilization of altigraph accelerometers to capture sedentary behaviors has its limitations. Other devices can offer enhanced differentiation between sitting standing or other forms of sedentary behaviors. As with most prior research, our sample was drawn from the general population (Hallgren et al., 2020), resulting in predominantly mild depressive symptom levels, potentially diminishing the probability of observing significant effects. Extrapolations to clinical samples, including individuals with major depressive diagnosed episodes, are not feasible. The sample size did not allow detecting effects of other potential confounders, nor social or cognitive variables that may further explain the observed associations. Pre- and early adolescents (below and above 12 years old) may differ in determinants of sedentary behaviors and in average time spent sitting (Jannsen et al., 2016); conducting well-powered analyses to test the role of age group as the moderator would require a

sample of > 400 dyads. The detected effects were small. Some of the underlying mechanisms discussed remain purely hypothetical and require further research. Our study accounted for long-term behavior change patterns (> 6 months between baseline and the last follow-up of sedentary time assessment (Prochaska & DiClemente, 1983). A stronger design would include multiple measurement points during periods > 6 months, this, however, could reduce the feasibility of the study to its participants and result in larger dropouts.

Conclusions

Our study provides novel evidence for time-lagged within-individual and across-individuals associations between depressive symptoms and accelerometer-assessed sedentary time among parents and their 9-15-year-old children. The most consistent pattern was found for within-individual associations forming a vicious cycle, with more sedentary time (baseline) predicting more depressive symptoms among children (8-month follow-up), and more depressive symptoms among children predicting higher sedentary time at the 8-month follow-up.

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Figure captions

Figure 1

Results of Path Analysis for the 'Sedentary Behaviors → Depressive Symptoms → Sedentary Behaviors' Dyadic Mediation Model

Note. ** $p < .01$; * $p < .05$. Dashed lines represent non-significant paths. Solid lines represent significant paths. Bold solid lines represent significant indirect effects. Black lines represent direct effects, grey lines represent covariances. Residuals of parent and child indicators of depressive symptoms at T2 as well as sedentary behaviors at T3 were allowed to covary. Depression = depressive symptoms; Physical activity = minutes of moderate-to-vigorous physical activity; T1 = Time 1, baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1. Sedentary time was computed as the average minutes of sedentary behavior per hour of wear time

Figure 2

Results of Path Analysis for the 'Depressive Symptoms→ Sedentary Behaviors → Depressive Symptoms' Dyadic Mediation Model

Note. ** $p < .01$; * $p < .05$. Dashed lines represent non-significant paths. Solid lines represent significant paths. Black lines represent direct effects, grey lines represent covariances. Bold solid lines represent significant indirect effects. Residuals of parent and child indicators of sedentary behaviors at T2 as well as depressive symptoms at T3 were allowed to covary. Depression = depressive symptoms; Physical activity = minutes of moderate-to-vigorous physical activity; T1 = Time 1, baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1. Sedentary time was computed as the average minutes of sedentary behavior per hour of wear time.

Figure 1

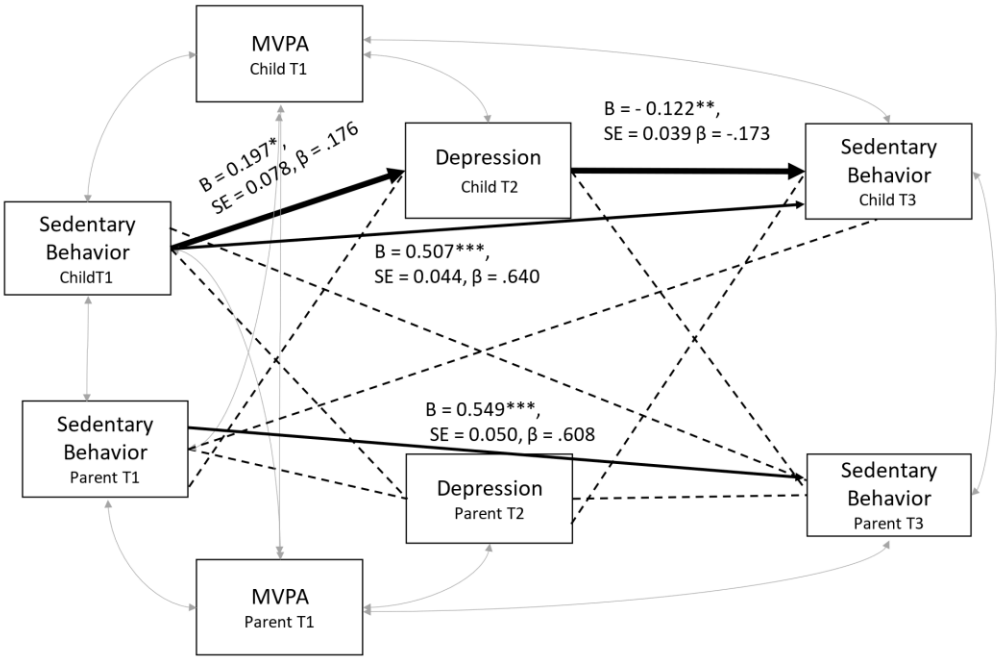

Figure 2

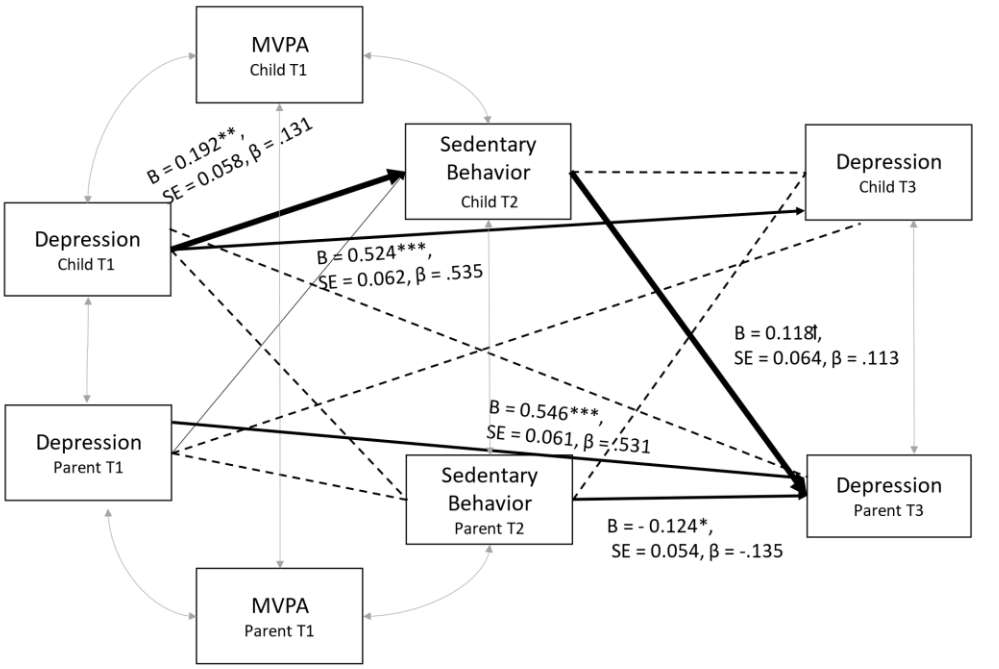

Table 1

Direct Effects in the 'Sedentary Behaviors → Depressive Symptoms → Sedentary Behaviors' Dyadic Mediation Model

Variables in the model and hypothesized associations	*B*	*SE*	β	*p*
Sedentary Behavior (CH, T1) → Depression (CH, T2)	**0.197**	**0.078**	**.176**	**.011**
Sedentary Behavior (CH, T1) → Depression (P, T2)	-0.033	0.059	-.040	.574
Sedentary Behavior (CH, T1) → Sedentary Behavior (CH, T3)	**0.507**	**0.044**	**.640**	**<.001**
Sedentary Behavior (CH, T1)→ Sedentary Behavior (P, T3)	0.028	0.062	.025	.656
Sedentary Behavior (P, T1) → Depression (CH, T2)	-0.004	0.063	-.005	.944
Sedentary Behavior (P, T1) → Depression (P, T2)	0.025	0.049	.037	.601
Sedentary Behavior (P, T1) → Sedentary Behavior (CH, T3)	0.047	0.035	.072	.180
Sedentary Behavior (P, T1)→ Sedentary Behavior (P, T3)	**0.549**	**0.050**	**.608**	**<.001**
Depression (CH, T2) → Sedentary Behavior (CH, T3)	**-0.122**	**0.039**	**-.173**	**.002**
Depression (CH, T2) → Sedentary Behavior (P, T3)	-0.053	0.056	-.053	.349
Depression (P, T2) → Sedentary Behavior (CH, T3)	-0.003	0.051	-.004	.947
Depression (P, T2) → Sedentary Behavior (P, T3)	-0.025	0.075	-.019	.739

Note. T1 = Time 1, baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1; CH = Child; P = Parent; Depression = depressive symptoms; Significant coefficients are marked in bold.

Table 2

Direct Effects in the 'Depressive Symptoms→ Sedentary Behaviors → Depressive Symptoms' Dyadic Mediation Model

Note. T1 = Time 1, baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1;

Variables in the model and hypothesized associations	*B*	*SE*	β	*p*
Depression (CH, T1) → Sedentary Behavior (CH, T2)	**0.192**	**0.058**	**.228**	**.001**
Depression (CH, T1) → Sedentary Behavior (P, T2)	-0.053	0.057	-.055	.352
Depression (CH, T1) → Depression (CH, T3)	**0.524**	**0.062**	**.535**	**<.001**
Depression (CH, T1) → Depression (P, T3)	0.004	0.053	.005	.936
Depression (P, T1) → Sedentary Behavior (CH, T2)	0.052	0.064	.053	.422
Depression (P, T1) → Sedentary Behavior (P, T2)	-0.002	0.080	-.001	.984
Depression (P, T1) → Depression (CH, T3)	-0.128	0.070	-.112	.067
Depression (P, T1) → Depression (P, T3)	**0.546**	**0.061**	**.531**	**<.001**
Sedentary Behavior (CH, T2) → Depression (CH, T3)	-0.054	0.073	-.046	.463
Sedentary Behavior (CH, T2) → Depression (P, T3)	0.118	0.064	.113	.064
Sedentary Behavior (P, T2) → Depression (CH, T3)	-0.003	0.062	-.003	.963
Sedentary Behavior (P, T2) → Depression (P, T3)	**-0.124**	**0.054**	**-.135**	**.022**

CH = Child; P = Parent; Depression = depressive symptoms; Significant coefficients are marked in bold.

Associations Between Depressive Symptoms and Sedentary Behaviors in Parent-Child Dyads: Longitudinal Effects Within- and Across Individuals

Supplemental Materials

Supplemental materials include:

- Results of attrition analysis
- Supplementary Table S1: Descriptive Statistics and Reliability of the Study Variables
  Supplementary Table S2: Correlations Between the Study Variables *(N = 203 Partner- Child Dyads)*
- Supplementary Table S3: Longitudinal Correlation Between Variables with the Baseline Measure Partialled-out
- Supplementary Table S4: Covariances for the 'Sedentary Behavior → Depression → Sedentary Behavior' Mediation Model
- Supplementary Table S5: Indirect Effects for the 'Sedentary Behavior → Depression → Sedentary Behavior' Mediation Model
- Supplementary Table S6: Direct Effect for the 'Sedentary Behavior → Depression → Sedentary Behavior' Mediation Model Tested with Additional Covariates
- Supplementary Table S7: Indirect Effects for the 'Sedentary Behavior → Depression → Sedentary Behavior' Mediation Model Tested with Additional Covariates
- Supplementary Table S8: Covariances for the 'Sedentary Behavior → Depression → Sedentary Behavior' Mediation Model Tested with Additional Covariates
- Supplementary Table S9: Covariances for the 'Depression→ Sedentary Behavior→ Depression' Mediation Model
- Supplementary Table S10: Indirect Effects for the 'Depression → Sedentary Behavior → Depression' Mediation Model

- Supplementary Table S11: Direct Effect for the ‘Depression→ Sedentary Behavior→ Depression’ Mediation Model Tested with Additional Covariates
- Supplementary Table S12: Indirect Effects for the ‘Depression → Sedentary Behavior → Depression’ Mediation Model Tested with Additional Covariates
- Supplementary Table S13: Covariances for the ‘Depression → Sedentary Behavior→ Depression’ Mediation Model Tested with Additional Covariates

Attrition Analysis. Among children, analyses for T1 data showed no differences between completers and drop-outs at T3 in gender, χ^2 (1, N = 203) = 0.12, p = .730; age, F(1, 201) = 0.37, p = .543; depression symptoms (1, 201) = 0.12, p = .733; SB time, F(1, 201) = 0.78, p = .378 or MVPA, F(1, 201) = 0.58, p = 447.

Regarding Partners, T1 data analyses showed that completers and those who dropped out at T3 did not differ in gender, χ^2 (1, N = 203) = 0.13, p = .718; age, F(1, 201) = 0.00, p = .983; economic status, F(1, 200) = 0.05, p = .825; education, F(1, 201) = 1.94, p = .166; or depressiveness F(1, 201) = 0.00, p = .991; SB time, F(1, 201) = 0.03, p = .865, or MVPA, F(1, 201) = 0.04, p = .151.

Supplementary Table S1

Descriptive Statistics and Reliability of the Study Variables

Variable	*M*	*SD*	Cronbach's alpha
Depression (CH, T1)	6.480	4.639	.811
Depression (P, T1)	5.672	4.474	.790
Depression (CH, T2)	5.568	4.979	.921
Depression (P, T2)	6.321	3.977	.850
Depression (CH, T3)	5.361	3.726	.911
Depression (P, T3)	4.878	4.081	.889
Sedentary Behavior (CH, T1)	38.455	4.473	
Sedentary Behavior (P, T1)	32.364	5.470	
Sedentary Behavior (CH, T2)	38.992	3.914	
Sedentary Behavior (P, T2)	32.451	4.519	
Sedentary Behavior (CH, T3)	39.487	3.544	
Sedentary Behavior (P, T3)	32.697	4.917	
MVPA (CH, T1)	3.583	1.589	
MVPA (P, T1)	5.431	2.085	
Age (CH)	11.409	1.257	
Age (P)	40.847	4.769	

Note. T1 = Time 1, the baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1; Depression = Depression Symptoms; CH = Child; P = Parent; MVPA = Moderate to Vigorous Physical Activity.

Supplementary Table S2

Correlations Between the Study Variables (N = 203 Parent- Child Dyads)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1) Depression (CH, T1)	--																	
2) Depression (P, T1)	.166*	--																
3) Depression (CH, T2)	.327**	.051	--															
4) Depression (P, T2)	.064	.383**	.206**	--														
5) Depression (CH, T3)	.506**	-.027	.414**	.005	--													
6) Depression (P, T3)	.130	.542**	.063	.399**	.054	--												
7) SB (CH, T1)	.210**	.026	.174*	-.039	.123	.022	--											
8) SB (P, T1)	.021	.028	.025	.025	.086	-.059	.276**	--										
9) SB (CH, T2)	.233**	.071	.049	-.014	.070	.120	.485**	.178*	--									
10) SB (P, T2)	-.076	-.014	-.033	.056	-.053	-.119	.091	.637**	.233**	--								
11) SB (CH, T3)	.194**	.049	-.058	-.052	.053	.037	.629**	.232**	.544**	.201**	--							
12) SB (P, T3)	.132	-.020	-.036	-.014	.149*	-.062	.173*	.615**	.274**	.553**	.414**	--						
13) Age (CH)	.072	.016	.089	-.011	.135	-.036	.177*	.094	.061	.063	.132	.087	--					
14) Age (P)	.040	.011	-.049	-.065	-.029	-.043	-.058	-.159*	-.192**	-.110	-.104	-.171*	.013	--				
15) Gender (CH)	.164*	.039	.185**	.028	.051	.089	.347**	.042	.319**	.078	.283**	-.007	.013	-.069	--			
16) Gender (P)	-.072	.036	-.029	-.056	-.033	-.076	.239**	.137	.263**	.178*	.275**	.151*	.001	-.150*	.185**	--		
17) Education (P)	-.054	-.116	-.140*	-.048	-.026	-.174*	-.054	.312**	.080	.322**	.049	.276**	-.003	-.063	-.069	.005	--	
18) ES (P)	-.002	-.127	-.046	.051	.042	-.064	.094	.111	.061	.013	.063	.015	.024	-.056	.048	-.029	.094	--

Note. T1 = Time 1, the baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1; CH = Children; P = Parent; Depression = Depression Symptoms; SB = Sedentary Behavior Time; ES = Economic Status; ** $p < .01$; * $p < .05$.

Supplementary Table S3

Longitudinal Correlation Between Different Variables with the Baseline Measure Partialled - out

Correlated Variables	**Partial-out Variable**	**Values and Significance**
Depression (CH, T2) -Depression (CH, T3)	Depression (CH, T1)	***r* = .305, *p* < .001**
Depression (CH, T2) - Depression (P, T3)	Depression (P, T1)	*r* = .042, *p* = .554
Depression (CH, T2) – SB (CH, T1)	Depression (CH, T1)	*r* = .114, *p* = .106
Depression (CH, T2) - SB (P, T1)	Depression (CH, T1)	*r* = .019, *p* = .785
Depression (CH, T2) - SB (CH, T3)	SB (CH, T1)	***r* = -.218, *p* = .002**
Depression (CH, T2) - SB (P, T3)	SB (P, T1)	*r* = -.065, *p* = .358
Depression (P, T2) - Depression (CH, T3)	Depression (CH, T1)	*r* = -.032, *p* = .648
Depression (P, T2) - Depression (P, T3)	Depression (P, T1)	***r* = .246, *p* < .001**
Depression (P, T2) - SB (CH, T1)	Depression (P, T1)	*r* = -.053, *p* = .452
Depression (P, T2) - SB (P, T1)	Depression (P, T1)	*r* = .016, *p* = .824
Depression (P, T2) - SB (CH, T3)	SB (CH, T1)	*r* = -.036, *p* = .614
Depression (P, T2) – SB (P, T3)	SB (P, T1)	*r* = -.038, *p* = .594
Depression (CH, T3) – SB (CH, T1)	Depression (CH, T1)	*r* = .020, *p* = .773
Depression (CH, T3) – SB (P, T1)	Depression (CH, T1)	*r* = .088, *p* = .215
Depression (CH, T3) – SB (CH, T2)	Depression (CH, T1)	*r* = -.057, *p* = .418
Depression (CH, T3) – SB (P, T2)	Depression (CH, T1)	*r* = -.017, *p* = .815
Depression (P, T3) – SB (CH, T1)	Depression (P, T1)	*r* = .010, *p* = .892
Depression (P, T3) – SB (P, T1)	Depression (P, T1)	*r* = -.088, *p* = .212
Depression (P, T3) – SB (CH, T2)	Depression (P, T1)	*r* = .097, *p* = .169
Depression (P, T3) – SB (P, T2)	Depression (P, T1)	*r = -132, p =.061*
SB (CH, T2) - SB (CH, T3)	SB (CH, T1)	***r* = .351, *p* < .001**
SB (CH, T2) - SB (P, T3)	SB (P, T1)	***r* = .212, *p* = .002**
SB (P, T2) - SB (CH, T3)	SB (CH, T1)	***r* = .186, *p* = .008**
SB (P, T2) - SB (P, T3)	SB (P, T1)	***r* = .266, *p* < .001**

Note. T1 = Time 1, the baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1; CH = Children; P = Parent; Depression = Depression Symptoms; SB = Sedentary Behavior Time; Significant coefficients are marked in bold; Statistical trends are marked in italics.

Supplementary Table S4
Covariances for the 'Sedentary Behavior → Depression → Sedentary Behavior' Mediation Model

Covariances			Estimate	*SE*	*p*
Depression (CH, T2)	←→	Depression (P, T2)	**3.601**	**1.269**	**.005**
Sedentary Behavior (CH, T1)	←→	Sedentary Behavior (P, T1)	**2.437**	**1.054**	**.021**
Sedentary Behavior (CH, T3)	←→	Sedentary Behavior (P, T3)	**4.557**	**0.779**	**<.001**
Sedentary Behavior (CH, T3)	←→	MVPA (CH, T1)	**0.502**	**0.196**	**.010**
Sedentary Behavior (P, T3)	←→	MVPA (P, T1)	**0.924**	**0.365**	**.011**
MVPA (CH, T1)	←→	Depression (CH, T2)	**1.097**	**0.396**	**.006**
MVPA (CH, T1)	←→	Sedentary Behavior (CH, T1)	**-4.591**	**0.585**	**<.001**
MVPA (CH, T1)	←→	MVPA (P, T1)	0.212	0.137	.123
MVPA (P, T1)	←→	Depression (P, T2)	0.556	0.379	.143
MVPA (P, T1)	←→	Sedentary Behavior (P, T1)	**-7.621**	**0.948**	**<.001**

Note. T1 = Time 1, the baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1; CH = Child; P = Parent; Depression = Depression Symptoms; MVPA = Moderate to Vigorous Physical Activity; Significant coefficients are marked in bold.

Supplementary Table S5

Indirect Effects for the 'Sedentary Behavior → Depression → Sedentary Behavior' Mediation Model

Simple indirect effects, total indirect effects, direct effects, total effects		Estimate	*SE*	95%BCI		*p*
				Lower	Higher	
Simple indirect effects	SB (CH, T1) →Depression (CH, T2) → SB (CH, T3)	**-0.024**	**0.014**	**-0.065**	**-0.005**	**.010**
	SB (CH, T1) →Depression (P, T2) → SB (CH, T3)	0.000	0.004	-0.008	0.011	.838
Direct effect	SB (CH, T1) → SB (CH, T3)	**0.507**	**0.046**	**0.413**	**0.594**	**<.001**
Total indirect effects	SB (CH, T1) →Depression (CH, T2) → SB (CH, T3) + SB (CH, T1) →Depression (P, T2) → SB (CH, T3)	**-0.030**	**0.015**	**-0.065**	**-0.002**	**.031**
Total effect	SB (CH, T1) →Depression (CH, T2) → SB (CH, T3) + SB (CH, T1) →Depression (P, T2) → SB (CH, T3) + SB (CH, T1) → SB (CH, T3)	**0.483**	**0.045**	**0.391**	**0.569**	**<.001**
Simple indirect effects	SB (CH, T1) →Depression (CH, T2) → SB (P, T3)	-0.001	0.017	-0.056	0.017	.369
	SB (CH, T1) →Depression (P, T2) → SB (P, T3)	0.001	0.008	-0.008	0.026	.469
Direct effect	SB (CH, T1) → SB (P, T3)	0.028	0.086	-0.126	0.211	.727
Total indirect effects	SB (CH, T1) →Depression (CH, T2) → SB (P, T3) + SB (CH, T1) →Depression (P, T2) → SB (P, T3)	-0.007	0.020	-0.052	0.026	.587
Total effect	SB (CH, T1) →Depression (CH, T2) → SB (P, T3) + SB (CH, T1) →Depression (P, T2) → SB (P, T3) + SB (CH, T1) → SB (P, T3)	0.018	0.082	-0.129	0.196	.791
Simple indirect effects	SB (P, T1) →Depression (CH, T2) → SB (CH, T3)	0.001	0.009	-0.013	0.024	.925
	SB (P, T1) →Depression (P, T2) → SB (CH, T3)	0.000	0.003	-0.008	0.006	.836
Direct effect	SB (P, T1) → SB (CH, T3)	0.047	0.036	-0.021	0.122	.164
Total indirect effects	SB (P, T1) →Depression (CH, T2) → SB (CH, T3) + SB (P, T1) →Depression (P, T2) → SB (CH, T3)	0.000	0.009	-0.014	0.024	.969
Total effects	SB (P, T1) →Depression (CH, T2) → SB (CH, T3) + SB (P, T1) →Depression (P, T2) → SB (CH, T3) + SB (P, T1) → SB (CH, T3)	0.047	0.037	-0.023	0.124	.183
Simple indirect effects	SB (P, T1) →Depression (CH, T2) → SB (P, T3)	0.000	0.006	- 0.010	0.017	.901
	SB (P, T1) →Depression (P, T2) → SB (P, T3)	-0.001	0.005	-0.019	0.006	.574
Direct effect	SB (P, T1) → SB (P, T3)	**0.549**	**0.059**	**0.427**	**0.663**	**<.001**
Total indirect effects	SB (P, T1) →Depression (CH, T2) → SB (P, T3) + SB (P, T1) →Depression (P, T2) → SB (P, T3)	0.000	0.008	-0.020	0.015	.774
Total effects	SB (P, T1) →Depression (CH, T2) → SB (P, T3) + SB (P, T1) →Depression (P, T2) → SB (P, T3) + SB (P, T1) → SB (P, T3)	**0.548**	**0.060**	**0.422**	**0.661**	**<.001**

Note. Values of indirect effect estimates presented in bold are significant at $p < .05$; Each bootstrap was based on 10,000 repetitions; BCI = Bias-corrected confidence intervals; BCI that do not include zero indicate a significant indirect effect; T1 = Time 1, the baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14months after T1; CH = Child; P = Parent; Depression = Depression Symptoms; SB = Sedentary Behavior Time.

Supplementary Table S6

Direct Effects for the 'Sedentary Behavior → Depression → Sedentary Behavior' Mediation Model Tested with Additional Covariates

Variables and hypothesized associations	B	*SE*	*β*	*p*
Sedentary Behavior (CH, T1) → Depression (CH, T2)	**0.199**	**0.078**	**.177**	**.011**
Sedentary Behavior (CH, T1) → Depression (P, T2)	-0.030	0.059	-.036	.609
Sedentary Behavior (CH, T1) → Sedentary Behavior (CH, T3)	**0.509**	**0.044**	**.639**	**<.001**
Sedentary Behavior (CH, T1)→ Sedentary Behavior (P, T3)	0.030	0.062	.028	.626
Sedentary Behavior (P, T1) → Depression (CH, T2)	-0.007	0.062	-.008	.905
Sedentary Behavior (P, T1) → Depression (P, T2)	0.023	0.049	.034	.634
Sedentary Behavior (P, T1) → Sedentary Behavior (CH, T3)	0.046	0.035	.071	.185
Sedentary Behavior (P, T1)→ Sedentary Behavior (P, T3)	**0.544**	**0.050**	**.604**	**<.001**
Depression (CH, T2) → Sedentary Behavior (CH, T3)	**-0.122**	**0.039**	**-.171**	**.002**
Depression (CH, T2) → Sedentary Behavior (P, T3)	-0.051	0.056	-.052	.362
Depression (P, T2) → Sedentary Behavior (CH, T3)	-0.006	0.051	-.007	.904
Depression (P, T2) → Sedentary Behavior (P, T3)	-0.024	0.074	-.019	.744

Note. T1 = Time 1, the baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1; CH = Child; P = Parent; ; Depression = Depression Symptoms; Significant coefficients are marked in bold; Model Fit: $\chi^2(45) = 57.578$, $p = .099$, $\chi^2/df = 1.28$, NFI = .921, CFI = .980, RMSEA = .037 (90% CI: .000, .063); Additional Covariates are: Age, Gender, Education, Economic Status, and Experimental Group Assignment.

Supplementary Table S7

Indirect Effects for the 'Sedentary Behavior → Depression → Sedentary Behavior' Mediation Model Tested with Additional Covariates

Simple indirect effects, total indirect effects, direct effects, total effects		Estimate	*SE*	95%BCI		*p*
				Lower	Higher	
Simple indirect effects	SB (CH, T1) →Depression (CH, T2) → SB (CH, T3)	**-0.024**	**0.014**	**-0.066**	**-0.005**	**.009**
	SB (CH, T1) →Depression (P, T2) → SB (CH, T3)	0.000	0.004	-0.007	0.012	.742
Direct effect	SB (CH, T1) → SB (CH, T3)	**0.509**	**0.047**	**0.414**	**0.598**	**<.001**
Total indirect effects	SB (CH, T1) →Depression (CH, T2) → SB (CH, T3) + SB (CH, T1) →Depression (P, T2) → SB (CH, T3)	**-0.024**	**0.015**	**-0.065**	**-0.002**	**.030**
Total effect	SB (CH, T1) →Depression (CH, T2) → SB (CH, T3) + SB (CH, T1) →Depression (P, T2) → SB (CH, T3) + SB (CH, T1) → SB (CH, T3)	**0.485**	**0.046**	**0.392**	**0.573**	**<.001**
Simple indirect effects	SB (CH, T1) →Depression (CH, T2) → SB (P, T3)	-0.010	0.017	-0.054	0.018	.386
	SB (CH, T1) →Depression (P, T2) → SB (P, T3)	0.001	0.008	-0.008	0.026	.502
Direct effect	SB (CH, T1) → SB (P, T3)	0.030	0.089	-0.132	0.216	.716
Total indirect effects	SB (CH, T1) →Depression (CH, T2) → SB (P, T3) + SB (CH, T1) →Depression (P, T2) → SB (P, T3)	-0.009	0.019	-0.052	0.026	.588
Total effect	SB (CH, T1) →Depression (CH, T2) → SB (P, T3) + SB (CH, T1) →Depression (P, T2) → SB (P, T3) + SB (CH, T1) → SB (P, T3)	0.021	0.085	-0.134	0.204	.774
Simple indirect effects	SB (P, T1) →Depression (CH, T2) → SB (CH, T3)	0.001	0.009	-0.013	0.025	.883
	SB (P, T1) →Depression (P, T2) → SB (CH, T3)	0.000	0.003	-0.009	0.005	.784
Direct effect	SB (P, T1) → SB (CH, T3)	0.046	0.036	-0.020	0.122	.169
Total indirect effects	SB (P, T1) →Depression (CH, T2) → SB (CH, T3) + SB (P, T1) →Depression (P, T2) → SB (CH, T3)	0.001	0.008	-0.014	0.024	.925
Total effects	SB (P, T1) →Depression (CH, T2) → SB (CH, T3) + SB (P, T1) →Depression (P, T2) → SB (CH, T3) + SB (P, T1) → SB (CH, T3)	0.047	0.037	-0.023	0.125	.188
Simple indirect effects	SB (P, T1) →Depression (CH, T2) → SB (P, T3)	0.000	0.006	- 0.009	0.018	.833
	SB (P, T1) →Depression (P, T2) → SB (P, T3)	-0.001	0.005	-0.019	0.006	.592
Direct effect	SB (P, T1) → SB (P, T3)	**0.544**	**0.059**	**0.422**	**0.657**	**<.001**
Total indirect effects	SB (P, T1) →Depression (CH, T2) → SB (P, T3) + SB (P, T1) →Depression (P, T2) → SB (P, T3)	0.000	0.010	-0.019	0.016	.848
Total effects	SB (P, T1) →Depression (CH, T2) → SB (P, T3) + SB (P, T1) →Depression (P, T2) → SB (P, T3) + SB (P, T1) → SB (P, T3)	**0.544**	**0.060**	**0.419**	**0.656**	**<.001**

Note. Values of indirect effect estimates presented in bold are significant at $p < .05$; Each bootstrap was based on 10,000 repetitions; BCI = Bias-corrected confidence intervals; BCI that do not include zero indicate a significant indirect effect; T1 = Time 1, the baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1; CH = Child; P = Parent; Depression = Depression Symptoms; SB = Sedentary Behavior Time; Model Fit: $\chi^2(45) = 57.578$, $p = .099$, $\chi^2/df = 1.28$, NFI = .921, CFI = .980, RMSEA = .037 (90% CI: .000, .063); Additional Covariates are: Age, Gender, Education, and Experimental Group Assignment.

Supplementary Table S8

Covariances for the 'Sedentary Behavior → Depression → Sedentary Behavior' SB' Mediation Model Tested with Additional Covariates

Covariances			Estimate	*SE*	*p*
Depression (CH, T2)	←→	Depression (P, T2)	**3.449**	**1.251**	**.006**
Sedentary Behavior (CH, T1)	←→	Sedentary Behavior (P, T1)	**2.585**	**0.960**	**.007**
Sedentary Behavior (CH, T3)	←→	Sedentary Behavior (P, T3)	**4.522**	**0.772**	**<.001**
Sedentary Behavior (CH, T3)	←→	MVPA (CH, T1)	**0.519**	**0.197**	**.008**
Sedentary Behavior (CH, T3)	←→	Age (CH)	**0.409**	**0.198**	**.039**
Sedentary Behavior (CH, T3)	←→	Gender (CH)	0.015	0.082	.854
Sedentary Behavior (CH, T3)	←→	Education (P)	0.286	0.260	.271
Sedentary Behavior (CH, T3)	←→	Economic status (P)	-0.048	0.155	.757
Sedentary Behavior (CH, T3)	←→	Condition	0.005	0.081	.949
Sedentary Behavior (P, T3)	←→	MVPA (P, T1)	**0.909**	**0.361**	**.012**
Sedentary Behavior (P, T3)	←→	Age (P)	-0.056	1.129	.960
Sedentary Behavior (P, T3)	←→	Gender (P)	-0.095	0.081	.240
Sedentary Behavior (P, T3)	←→	Education (P)	0.578	0.375	.123
Sedentary Behavior (P, T3)	←→	Economic status (P)	-0.250	0.224	.265
Sedentary Behavior (P, T3)	←→	Condition	-0.068	0.116	.559
MVPA (CH, T1)	←→	Depression (CH, T2)	**1.156**	**0.399**	**.004**
MVPA (CH, T1)	←→	Sedentary Behavior (CH, T1)	**-4.536**	**0.578**	**<.001**
MVPA (CH, T1)	←→	MVPA (P, T1)	0.177	0.131	.177
MVPA (CH, T1)	←→	Education (P)	0.184	0.152	.226
MVPA (CH, T1)	←→	Economic status (P)	-0.105	0.090	.244
MVPA (P, T1)	←→	Depression (P, T2)	0.575	0.378	.128
MVPA (P, T1)	←→	Sedentary Behavior (P, T1)	**-7.667**	**0.946**	**<.001**
MVPA (P, T1)	←→	Education (P)	**-0.654**	**0.217**	**.003**
MVPA (P, T1)	←→	Economic status (P)	-0.055	0.120	.645
Age (CH)	←→	Depression (CH, T2)	0.723	0.392	.065
Age (CH)	←→	Sedentary Behavior (CH, T1)	**1.822**	**0.393**	**<.001**
Age (CH)	←→	MVPA (CH, T1)	-0.175	0.134	.192
Age (CH)	←→	Age (P)	0.477	0.377	.206
Age (P)	←→	Depression (P, T2)	-0.813	1.199	.498
Age (P)	←→	Sedentary Behavior (P, T1)	2.472	1.672	.139
Age (P)	←→	MVPA (P, T1)	**-1.600**	**0.679**	**.018**
Gender (CH)	←→	Depression (CH, T2)	0.149	0.163	.361
Gender (CH)	←→	Sedentary Behavior (CH, T1)	**0.361**	**0.145**	**.013**
Gender (CH)	←→	MVPA (CH, T1)	**-0.151**	**0.056**	**.007**
Gender (P)	←→	Depression (P, T2)	-0.083	0.086	.335
Gender (P)	←→	Sedentary Behavior (P, T1)	-0.191	0.120	.110
Gender (P)	←→	MVPA (P, T1)	-0.034	0.047	.477
Education (P)	←→	Depression (CH, T2)	-0.810	0.477	.089
Education (P)	←→	Depression (P, T2)	-0.364	0.364	.318
Education (P)	←→	Sedentary Behavior (CH, T1)	-0.453	0.415	.275
Education (P)	←→	Sedentary Behavior (P, T1)	**2.578**	**0.585**	**<.001**
Education (P)	←→	Economic status (P)	0.116	0.088	.185
Economic status (P)	←→	Depression (CH, T2)	-0.291	0.283	.303
Economic status (P)	←→	Depression (P, T2)	0.155	0.216	.473
Economic status (CH)	←→	Sedentary Behavior (CH, T1)	0.240	0.241	.320
Economic status (CH)	←→	Sedentary Behavior (P, T1)	0.433	0.315	.169

Condition	←→	Sedentary Behavior (CH, T1)	-0.136	0.145	.349
Condition	←→	Sedentary Behavior (P, T1)	-0.031	0.113	.784

Note. T1 = Time 1, the baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1; CH = Child; P = Parent; Depression = Depression Symptoms; MVPA = Moderate to Vigorous Physical Activity; Condition = the experimental condition (participating in a planning intervention) = 1, control (education) group = 0; Significant coefficients are marked in bold; Model Fit*:* $\chi^2(45) = 57.578$, $p = .099$, $\chi^2/df = 1.28$, NFI = .921, CFI = .980, RMSEA = .037 (90% CI: .000, .063); Additional Covariates are: Age, Gender, Education, Economic Status, and Experimental Group Assignment.

Supplementary Table S9

Covariances for the 'Depression → Sedentary Behavior → Depression' Mediation Model

Covariances			Estimate	*SE*	*p*
Depression (CH, T1)	↔	Depression (P, T1)	**3.161**	**1.306**	**.016**
Depression (CH, T3)	↔	Depression (P, T3)	0.930	0.918	.311
Sedentary Behavior (CH, T2)	↔	Sedentary Behavior (P, T2)	**3.130**	**0.964**	**.001**
MVPA (CH, T1)	↔	Depression (CH, T1)	-0.412	0.496	.406
MVPA (CH, T1)	↔	Sedentary Behavior (CH, T2)	**-1.992**	**0.429**	**<.001**
MVPA (CH, T1)	↔	MVPA (P, T1)	**0.654**	**0.187**	**<.001**
MVPA (P, T1)	↔	Depression (P, T1)	-0.684	0.562	.223
MVPA (P, T1)	↔	Sedentary Behavior (P, T2)	**-5.261**	**0.727**	**<.001**

Note. T1 = Time 1, the baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1; CH = Child; P = Parent; Depression = Depression Symptoms; MVPA = Moderate to Vigorous Physical Activity; Significant coefficients are marked in bold.

Supplementary Table S10

Indirect Effects for the 'Depression → Sedentary Behavior → Depression' Mediation Model

Simple indirect effects, total indirect effects, direct effects, total effects		**Estimate**	***SE***	**95%BCI**		***p***
				Lower	**Higher**	
Simple indirect effects	Depression (CH, T1) → SB (CH, T2) → Depression (CH, T3)	- 0.010	0.019	-0.060	0.019	.426
	Depression (CH, T1) → SB (P, T2) → Depression (CH, T3)	0.000	0.005	-0.010	0.014	.899
Direct effect	Depression (CH, T1) → Depression (CH, T3)	**0.524**	**0.061**	**0.386**	**0.676**	**<.001**
Total indirect effects	Depression (CH, T1) → SB (CH, T2) → Depression (CH, T3) + Depression (CH, T1) → SB (P, T2) → Depression (CH, T3)	-0.010	0.020	-0.060	0.024	.485
Total effects	Depression (CH, T1) → SB (CH, T2) → Depression (CH, T3) + Depression (CH, T1) → SB (P, T2) → Depression (CH, T3) + Depression (CH, T1) → Depression (CH, T3)	**0.513**	**0.074**	**0.373**	**0.664**	**<.001**
Simple indirect effects	Depression (CH, T1) → SB (CH, T2) → Depression (P, T3)	**0.023**	**0.013**	**0.003**	**0.057**	**.022**
	Depression (CH, T1) → SB (P, T2) → Depression (P, T3)	0.007	0.009	-0.006	0.031	.253
Direct effect	Depression (CH, T1) → Depression (P, T3)	0.004	0.057	-0.096	0.010	.930
Total indirect effects	Depression (CH, T1) → SB (CH, T2) → Depression (P, T3) + Depression (CH, T1) → SB (P, T2) → Depression (P, T3)	**0.029**	**0.005**	**0.006**	**0.063**	**.017**
Total effects	Depression (CH, T1) → SB (CH, T2) → Depression (P, T3) + Depression (CH, T1) → SB (P, T2) → Depression (P, T3) + Depression (CH, T1) → Depression (P, T3)	0.033	0.014	-0.058	0.121	.474
Simple indirect effects	Depression (P, T1) → SB (CH, T2) → Depression (CH, T3)	-0.003	0.008	-0.033	0.006	.373
	Depression (P, T1) → SB (P, T2) → Depression (CH, T3)	0.000	0.006	-0.013	0.012	.971
Direct effect	Depression (P, T1) → Depression (CH, T3)	-0.112	0.056	- 0.262	0.002	.054
Total indirect effects	Depression (P, T1) → SB (CH, T2) → Depression (CH, T3) + Depression (P, T1) → SB (P, T2) → Depression (CH, T3)	-0.003	0.010	- 0.031	0.011	.549
Total effects	Depression (P, T1) → SB (CH, T2) → Depression (CH, T3) + Depression (P, T1) → SB (P, T2) → Depression (CH, T3) + Depression (P, T1) → Depression (CH, T3)	**-0.131**	**0.067**	**-0.266**	**-.002**	**.045**
Simple indirect effects	Depression (P, T1) → SB (CH, T2) → Depression (P, T3)	0.006	0.009	-0.006	0.034	.292
	Depression (P, T1) → SB (P, T2) → Depression (P, T3)	0.000	0.012	- 0.025	0.023	.931
Direct effect	Depression (P, T1) → Depression (P, T3)	**0.531**	**0.070**	**0.410**	**0.683**	**<.001**
Total indirect effects	Depression (P, T1) → SB (CH, T2) → Depression (P, T3) + Depression (P, T1) → SB (P, T2) → Depression (P, T3)	0.006	0.013	- 0.018	0.035	.506
Total effects	Depression (P, T1) → SB (CH, T2) → Depression (P, T3) + Depression (P, T1) → SB (P, T2) → Depression (P, T3) + Depression (P, T1) → Depression (P, T3)	**0.552**	**0.073**	**0.410**	**0.697**	**<.001**

Note. Values of indirect effect estimates presented in bold are significant at $p < .05$; Each bootstrap was based on 10,000 repetitions; BCI = Bias-corrected confidence intervals; BCI that do not include zero indicate a significant indirect effect; T1 = Time 1, the baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1; CH = Child; P = Parent; Depression = Depression Symptoms; SB = Sedentary Behavior Time.

Supplementary Table S11

Direct Effect for the 'Depression → Sedentary Behavior → Depression' Mediation Model Tested with Additional Covariates

Variables and hypothesized associations	B	*SE*	*β*	*p*
Depression (CH, T1) → Sedentary Behavior (CH, T2)	**0.188**	**0.058**	**.223**	**.001**
Depression (CH, T1) → Sedentary Behavior (P, T2)	-0.045	0.056	-.046	.425
Depression (CH, T1) → Depression (CH, T3)	**0.523**	**0.062**	**.533**	**<.001**
Depression (CH, T1) → Depression (P, T3)	-0.009	0.053	-.010	.868
Depression (P, T1) → Sedentary Behavior (CH, T2)	0.049	0.062	.050	.423
Depression (P, T1) → Sedentary Behavior (P, T2)	0.001	0.080	.001	.994
Depression (P, T1) → Depression (CH, T3)	-0.130	0.069	-.114	.060
Depression (P, T1) → Depression (P, T3)	**0.549**	**0.060**	**.532**	**<.001**
Sedentary Behavior (CH, T2) → Depression (CH, T3)	-0.055	0.073	-.047	.449
Sedentary Behavior (CH, T2) → Depression (P, T3)	**0.139**	**0.062**	**.133**	**.026**
Sedentary Behavior (P, T2) → Depression (CH, T3)	-0.007	0.062	-.007	.912
Sedentary Behavior (P, T2) → Depression (P, T3)	**-0.126**	**0.054**	**-.137**	**.019**

Note. T1 = Time 1, the baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1; CH = Child; P = Parent; Depression = Depression Symptoms; Significant coefficients are marked in bold; Model Fit*:* $\chi^2(47) = 69.995$, $p = .016$, $\chi^2/df = 1.49$, NFI = .849, CFI = .936, RMSEA = .049 (90% CI: .022, .072); Additional Covariates are: Age, Gender, Education, Economic Status, and Experimental Group Assignment.

Supplementary Table S12

Indirect Effects for the 'Depression → Sedentary Behavior → Depression' Mediation Model Tested with Additional Covariates

Simple indirect effects, total indirect effects, direct effects, total effects		**Estimate**	***SE***	**95%BCI**		***p***
				Lower	**Higher**	
Simple indirect effects	Depression (CH, T1) → SB (CH, T2) → Depression (CH, T3)	- 0.010	0.019	-0.060	0.019	.413
	Depression (CH, T1) → SB (P, T2) → Depression (CH, T3)	0.000	0.005	-0.008	0.015	.801
Direct effect	Depression (CH, T1) → Depression (CH, T3)	**0.523**	**0.075**	**0.384**	**0.676**	**<.001**
Total indirect effects	Depression (CH, T1) → SB (CH, T2) → Depression (CH, T3) + Depression (CH, T1) → SB (P, T2) → Depression (CH, T3)	-0.010	0.020	-0.059	0.024	.493
Total effects	Depression (CH, T1) → SB (CH, T2) → Depression (CH, T3) + Depression (CH, T1) → SB (P, T2) → Depression (CH, T3) + Depression (CH, T1) → Depression (CH, T3)	**0.513**	**0.075**	**0.372**	**0.664**	**<.001**
Simple indirect effects	Depression (CH, T1) → SB (CH, T2) → Depression (P, T3)	**0.026**	**0.015**	**0.005**	**0.065**	**.012**
	Depression (CH, T1) → SB (P, T2) → Depression (P, T3)	0.006	0.009	-0.007	0.029	.316
Direct effect	Depression (CH, T1) → Depression (P, T3)	-0.009	0.050	-0.110	0.084	.840
Total indirect effects	Depression (CH, T1) → SB (CH, T2) → Depression (P, T3) + Depression (CH, T1) → SB (P, T2) → Depression (P, T3)	**0.032**	**0.015**	**0.008**	**0.070**	**.010**
Total effects	Depression (CH, T1) → SB (CH, T2) → Depression (P, T3) + Depression (CH, T1) → SB (P, T2) → Depression (P, T3) + Depression (CH, T1) → Depression (P, T3)	0.023	0.045	-0.068	0.118	.629
Simple indirect effects	Depression (P, T1) → SB (CH, T2) → Depression (CH, T3)	-0.003	0.008	-0.032	0.005	.371
	Depression (P, T1) → SB (P, T2) → Depression (CH, T3)	0.000	0.006	-0.013	0.012	.959
Direct effect	Depression (P, T1) → Depression (CH, T3)	-0.130	0.067	- 0.264	0.000	.051
Total indirect effects	Depression (P, T1) → SB (CH, T2) → Depression (CH, T3) + Depression (P, T1) → SB (P, T2) → Depression (CH, T3)	-0.003	0.009	- 0.030	0.011	.560
Total effects	Depression (P, T1) → SB (CH, T2) → Depression (CH, T3) + Depression (P, T1) → SB (P, T2) → Depression (CH, T3) + Depression (P, T1) → Depression (CH, T3)	**-0.133**	**0.067**	**-0.265**	**-.003**	**.045**
Simple indirect effects	Depression (P, T1) → SB (CH, T2) → Depression (P, T3)	0.007	0.010	-0.008	0.035	.302
	Depression (P, T1) → SB (P, T2) → Depression (P, T3)	0.000	0.012	- 0.026	0.023	.981
Direct effect	Depression (P, T1) → Depression (P, T3)	**0.549**	**0.068**	**0.418**	**0.685**	**<.001**
Total indirect effects	Depression (P, T1) → SB (CH, T2) → Depression (P, T3) + Depression (P, T1) → SB (P, T2) → Depression (P, T3)	0.007	0.013	- 0.017	0.035	.498
Total effects	Depression (P, T1) → SB (CH, T2) → Depression (P, T3) + Depression (P, T1) → SB (P, T2) → Depression (P, T3) + Depression (P, T1) → Depression (P, T3)	**0.556**	**0.071**	**0.419**	**0.698**	**<.001**

Note. Values of indirect effect estimates presented in bold are significant at $p < .05$; Each bootstrap was based on 10,000 repetitions; BCI = Bias-corrected confidence intervals; BCI that do not include zero indicate a significant indirect effect; T1 = Time 1, the baseline; T2 = Time 2, 8 months after T1; T3 = Time 3, 14 months after T1; CH = Child; P = Parent; Depression = Depression Symptoms; SB = Sedentary Behavior Time; Model Fit*:* $\chi^2(47) = 69.995$, $p = .016$, $\chi^2/df = 1.49$, NFI = .849, CFI = .936, RMSEA = .049 (90% CI: .022, .072); Additional Covariates are: Age, Gender, Education, Economic Status, and Experimental Group Assignment

Supplementary Table S13
Covariances for the 'Depression → Sedentary Behavior → Depression' Mediation Model Tested with Additional Covariates

Covariances			Estimate	*SE*	*P*
Depression (CH, T1)	←→	Depression (P, T1)	**3.047**	**1.284**	**.018**
Depression (CH, T3)	←→	Depression (P, T3)	1.076	0.904	.234
Depression (CH, T3)	←→	Age (CH)	-0.141	0.317	.657
Depression (CH, T3)	←→	Gender (CH)	0.225	0.134	.093
Depression (CH, T3)	←→	Education (P)	-0.026	0.375	.946
Depression (CH, T3)	←→	Economic status (P)	0.084	0.224	.707
Depression (CH, T3)	←→	Condition	-0.007	0.118	.950
Depression (P, T3)	←→	Age (P)	-2.101	1.099	.056
Depression (P, T3)	←→	Gender (P)	-0.063	0.079	.426
Depression (P, T3)	←→	Education (P)	-0.441	0.326	.176
Depression (P, T3)	←→	Economic status (P)	-0.057	0.193	.768
Depression (P, T3)	←→	Condition	0.107	0.102	.291
Sedentary Behavior (CH, T2)	←→	Sedentary Behavior (P, T2)	**2.540**	**0.911**	**.005**
MVPA (CH, T1)	←→	Depression (CH, T1)	-4.719	7.033	.502
MVPA (CH, T1)	←→	Sedentary Behavior (CH, T2)	**-28.324**	**6.078**	**<.001**
MVPA (CH, T1)	←→	MVPA (P, T1)	**8.243**	**2.544**	**.001**
MVPA (CH, T1)	←→	Education (P)	0.366	2.126	.863
MVPA (CH, T1)	←→	Economic status (P)	-1.959	1.286	.128
MVPA (P, T1)	←→	Depression (P, T1)	-0.701	0.563	.213
MVPA (P, T1)	←→	Sedentary Behavior (P, T2)	**-5.344**	**0.732**	**<.001**
MVPA (P, T1)	←→	Education (P)	**-0.574**	**0.215**	**.008**
MVPA (P, T1)	←→	Economic status (P)	-0.057	0.120	.639
Age (CH)	←→	Depression (CH, T1)	**0.943**	**0.401**	**.019**
Age (CH)	←→	Sedentary Behavior (CH, T2)	**1.224**	**0.328**	**<.001**
Age (CH)	←→	MVPA (CH, T1)	-1.480	1.852	.424
Age (CH)	←→	Age (P)	0.651	0.389	.094
Age (P)	←→	Depression (P, T1)	0.669	1.284	.602
Age (P)	←→	Sedentary Behavior (P, T2)	**2.776**	**1.399**	**.047**
Age (P)	←→	MVPA (P, T1)	**-1.366**	**0.663**	**.039**
Gender (CH)	←→	Depression (CH, T1)	0.154	0.158	.330
Gender (CH)	←→	Sedentary Behavior (CH, T2)	0.051	0.125	.683
Gender (CH)	←→	MVPA (CH, T1)	**-2.021**	**0.767**	**.008**
Gender (P)	←→	Depression (P, T1)	0.001	0.092	.995
Gender (P)	←→	Sedentary Behavior (P, T2)	-0.062	0.099	.530
Gender (P)	←→	MVPA (P, T1)	-0.013	0.047	.777
Education (P)	←→	Depression (CH, T1)	-0.210	0.463	.650
Education (P)	←→	Depression (P, T1)	-0.675	0.414	.103
Education (P)	←→	Sedentary Behavior (CH, T2)	0.530	0.367	.149
Education (P)	←→	Sedentary Behavior (P, T2)	**2.060**	**0.474**	**<.001**
Education (P)	←→	Economic status (P)	0.118	0.087	.177
Economic status (P)	←→	Depression (CH, T1)	-0.028	0.268	.915
Economic status (P)	←→	Depression (P, T1)	-0.402	0.234	.086
Economic status (CH)	←→	Sedentary Behavior (CH, T2)	0.169	0.212	.425
Economic status (CH)	←→	Sedentary Behavior (P, T2)	0.034	0.256	.893
Condition	←→	Sedentary Behavior (CH, T2)	0.202	0.106	.058
Condition	←→	Sedentary Behavior (P, T2)	0.084	0.107	.434

Note. T1 = Time 1, the baseline; T2 = Time 2, 2 months after T1; T3 = Time 3, 8 months after T1; CH = Child; P = Parent; Depression = Depression Symptoms; MVPA = Moderate to Vigorous Physical Activity; Condition = the experimental condition (participating in a planning intervention) = 1, control (education) group = 0; Significant coefficients are marked in bold; Model Fit*:* $\chi^2(47) = 69.995$, $p = .016$, $\chi^2/df = 1.49$, NFI = .849, CFI = .936, RMSEA = .049 (90% CI: .022; .072); Additional covariates are: Age, Gender, Education, Economic Status, and Experimental Group Assignment.