



# Exceeding 2-h sedentary time per day is not associated with moderate to severe spinal pain in 11- to 13-year-olds: a cross-sectional analysis

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## Abstract

Neck, mid-back and low back pain, collectively known as spinal pain, become more common with increasing age across childhood and adolescence. A common belief among the general community is that sedentary time, including screen time, in adolescents is associated with spinal pain. We aimed to investigate whether exceeding 2-h of sedentary time per day is associated with moderate to severe spinal pain in a sample of Danish adolescents aged 11–13 years. We performed a cross-sectional analysis of the SPACE study baseline data (2010). Adolescents self-reported their spinal pain (outcome) via the Young Spine Questionnaire and duration of engagement in sedentary behaviours (exposure). We provide estimates of associations as odds ratios with 95% confidence intervals, stratified by age and sex. The sample comprised 1,303 adolescents (48.7% female, mean age 12.5 years, range 10.9–14.3 years). Approximately 9 out of 10 adolescents exceeded 2-h sedentary time on weekdays outside of school (88.9%) and weekend days (89.9%). Close to one-quarter, 23.3% (95%CI: 21.0–25.6), of participants experienced moderate to severe spinal pain. We found no association between exceeding 2-h sedentary time per day and experiencing moderate to severe spinal pain; odds ratios ranged from 0.34 (95%CI: 0.04–3.20) to 4.65 (95%CI: 0.26–82.44).

**Conclusion:** We found no association between exceeding 2- or 5-h of sedentary time per day and moderate to severe spinal pain in this sample of 11–13-year-old Danish adolescents. Our cross-sectional analysis does not consider the longitudinal or complex sequences of events necessary to address predictive or causal questions.

## What is Known:

- Up to a third of adolescents experience moderate to severe spinal pain, predisposing them to chronic spinal pain in adulthood.
- Frequent and excessive sedentary time is associated with poor overall health in adolescents; there is conflicting evidence to suggest whether it is also related to spinal pain.

## What is New:

- We found no association between sedentary time and moderate to severe spinal pain in 11- to 13-year-old Danes.

**Keywords** Sedentary time · Screen time · Back pain · Adolescent · Child

## Introduction

Neck, mid-back and low back pain, collectively known as spinal pain, become more common with increasing age across childhood and adolescence [1]. Though most spinal pain episodes are short-lived, many adolescents experience spinal pain episodes that are frequent or persistent

in nature [2]. Those experiencing frequent pain are more likely to report higher intensity pain and a greater impact of their pain on daily activities [3, 4]. For example, they more often miss school, limit participation in physical activity, experience sleep problems, use pain medication and seek health care [3, 4]. This group of children and adolescents are at a higher risk of spinal pain in adulthood [5]. By age 20, neck and low back pain are the leading cause of years lived with disability [6]. Adolescents who experience intense, frequent or persistent spinal pain should be the focus of high-quality research investigating predictive factors for early intervention and prevention [5, 7].

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Time spent sitting becomes more common from childhood to late adolescence [8]. For example, children ( $\leq 12$  years) spend 41% of their time after school sedentary compared to 57% in adolescents ( $> 12$  years) [9]. More than 2-h sedentary time per day has been linked to adverse health outcomes such as low fitness, cardiometabolic disease, disrupted behaviour and psychological distress in adolescents [8, 10]. In an attempt to reduce sedentary time in the community, countries including Australia, UK, USA and Canada have proposed sedentary time recommendations for young people in the form of public health guidelines. These guidelines recommend limiting additional screen-time (outside of school hours) to less than 2-h per day [11, 12].

Evidence suggests frequent and excessive sedentary time is associated with poor overall health in adolescents but there is conflicting evidence to suggest whether it is also related to spinal pain [13]. We aimed to investigate whether 11–13-year-old Danish adolescents who exceeded 2-h per day of sedentary time report moderate to severe spinal pain more often than those who do not.

## Methods

### Study design, setting and participants

The School site, Play-spot, Active transport, Club fitness and Environment (SPACE) study was a randomised controlled trial that ran from 2010 to 2012 in Southern Denmark. The SPACE study enrolled 1348 school students aged 11–13 years and evaluated the effectiveness of a multicomponent intervention promoting increased physical activity. Students in 5th–6th grade from 14 schools were enrolled. Parents received a passive informed consent and could withdraw their child at any stage [14]. Further information on the SPACE study protocol and outcomes have been reported elsewhere [14, 15]. We completed a cross-sectional analysis on the SPACE baseline data and have reported our findings adhering to the STROBE statement. This analysis was planned and conducted after data were collected.

### Outcome

Six items from the Young Spine Questionnaire (YSQ) [16] were used to identify adolescents who self-reported neck, mid-back and/or low back pain in the last week *and* at least one episode of moderate to severe neck, mid-back and/or low back pain in their life. Adolescents' pain in the last week was recorded via the question "Have you had neck pain in the last week?" Response options were 0, no; or

1, yes. This question was repeated for the mid-back and low back. Adolescents' worst pain intensity was recorded via the Faces Pain Scale-Revised (FPS-R). This scale was repeated each for the neck, mid-back and low back. The FPS-R uses six face drawings to express increasing pain intensity from "no pain" (equivalent to 0/10 on a numeric scale) to "very much pain" (10/10 numeric scale). The third face on the FPS-R (4/10 numeric scale) was selected as the cut point to delineate mild from moderate to severe pain in children and adolescents [16–19]. Participants were categorised as follows: 0, no or mild intensity neck/mid-back/low back pain (FPS-R faces 1–2); or 1, moderate to severe neck/mid-back/low back pain (FPS-R faces 3–6). We also combined the three spine regions (neck/mid-back/low back) and dichotomised as above for 0, no or mild intensity spinal pain; or 1, moderate to severe spinal pain. The YSQ has shown strong content validity [16] and the FPS-R has shown strong positive correlation ( $r=0.92$ ) to the visual analogue scale in children 5–12 years [20].

### Exposure

Sedentary behaviour is defined as "Any waking behavior characterised by an energy expenditure  $\leq 1.5$  metabolic equivalents (METs), while in a sitting, reclining or lying posture" [21]. Sedentary time, i.e. time spent in any sedentary behaviour, was measured via two self-reported questionnaire items, one each for weekdays (outside of school hours) and weekend days. Both questions asked: "About how many hours do you usually spend a day... A. Watching TV or DVD? (Not just having it run in the background), B. Chatting or surfing the web, playing computer games, x-box or similar? and C. Other, where you sit or lie, for example, reading, homework, being creative, playing music?". Response options were on a 6-point scale (0, 1, 2, 3, 4 and 5 + h). We totalled the number of sedentary hours for weekdays (outside school hours) and weekends separately. For our primary analysis, these totals were dichotomised at 2-h per day. For our sensitivity analysis, we dichotomised the totals at 5-h to measure the association between greater sedentary time and spinal pain. These questions have been validated in children and adolescents and have been previously used in large international surveys such as the Health Behaviour in School-age Children (HBSC) [14].

### Statistical methods

We inspected the data and removed cases with no response to all sedentary time or spinal pain variables. The frequency of missing data was analysed for each variable in

the remaining dataset. All variables had <0.5% missing data, and no further cases were removed. The frequencies of exceeding 2- and 5-h of sedentary time and experiencing moderate to severe spinal pain were described using counts and proportions. We performed a stratified analysis to control for confounding and assess effect modification. We stratified the data by sex (boys, girls) and age (11, 12 and 13 years) and performed chi-squared tests within each stratum. Our primary analysis assesses whether exceeding 2-h of sedentary time per day was independent of experiencing moderate to severe spinal pain, neck pain, mid-back pain or low back pain. Our sensitivity analysis was conducted using the exposure of exceeding 5-h of sedentary time per day. Estimates of the associations were reported as odds ratios (OR) and 95% confidence intervals (95%CI). Analyses were conducted using IBM SPSS Statistics version 26.

## Results

Of the 1348 Danish adolescents included in the SPACE baseline data, we included 1303 (96.7%) in this cross-sectional analysis. We excluded 45 adolescents, 35 were missing all variables of interest and a further 10 were missing all spinal

pain variables. We kept 13 adolescents in our analyses who were missing one or more spinal pain variables. The highest frequency of missing data was 0.4% ( $n=5$ ) for the combined spinal pain variable.

The participants' mean age was  $12.5 \pm 0.6$  years (range: 10.9–14.3 years), 48.7% were females. Most adolescents exceeded 2-h of sedentary time on weekdays outside of school hours (88.9%) and on weekend days (89.9%). Older adolescents and males exceeded 2-h of sedentary time per day more frequently than younger adolescents and females. In our sensitivity analysis, 29.1% of participants exceeded 5-h of sedentary time per day on weekdays outside of school hours and 46.1% on weekend days. Close to one-quarter of adolescents (23.3%) experienced moderate to severe spinal pain. Moderate to severe neck pain (14.1%) was more prevalent than mid-back pain (11.1%) and low back pain (7.1%) (Table 1).

We found that experiencing moderate to severe spinal pain, in any region, was independent of exceeding 2- or 5-h sedentary time per day (Table 2). There was little to no evidence to support an association between sedentary time and moderate to severe spinal pain in this sample, confidence intervals for all odds ratios spanned across 1. There was no consistency in the direction of associations

**Table 1** Characteristics of 1303 Danish schoolchildren aged 11–13 years

	Boys	Girls	11 years	12 years	13 years	Total sample
	% 51.3	48.7	27.2	51.7	21.1	<b>100</b>
	<i>n</i> 669	634	355 (186F)	673 (328F)	275 (120F)	<b>1303</b>
Mean age	$12.5 \pm 0.6$	$12.4 \pm 0.6$	$11.7 \pm 0.2$	$12.5 \pm 0.3$	$13.3 \pm 0.3$	<b><math>12.5 \pm 0.6</math></b>
<b>Sedentary time, weekday outside school</b>						
> 2 h/d	% 90.7 (88.4–92.8)	87.1 (84.3–89.5)	83.4 (79.2–87.0)	89.6 (87.1–91.7)	94.5 (91.4–96.8)	<b>88.9 (87.2–90.6)</b>
	<i>n</i> 607	552	296	603	260	<b>1159</b>
> 5 h/d	% 31.5 (28.1–35.1)	26.5 (23.2–30.0)	23.1 (18.9–27.7)	28.4 (25.1–31.9)	38.5 (32.9–44.4)	<b>29.1 (26.6–31.6)</b>
	<i>n</i> 211	168	82	191	106	<b>379</b>
<b>Sedentary time, weekend day</b>						
> 2 h/d	% 91.6 (89.4–93.5)	88.2 (85.5–90.5)	85.9 (82–89.2)	90.6 (88.3–92.7)	93.5 (90.1–95.9)	<b>89.9 (88.2–91.5)</b>
	<i>n</i> 613	559	305	610	257	<b>1172</b>
> 5 h/d	% 51.0 (47.2–54.7)	41.0 (37.2–44.9)	40.8 (35.8–46.0)	46.8 (43.1–50.6)	51.3 (45.4–57.1)	<b>46.1 (43.4–48.8)</b>
	<i>n</i> 341	260	145	315	141	<b>601</b>
<b>Moderate to severe pain</b>						
Spinal	% 21.1 (18.1–24.3)	25.6 (22.3–29.1)	20.7 (16.8–25.2)	22.4 (19.3–25.6)	28.7 (23.6–34.3)	<b>23.3 (21.0–25.6)</b>
	<i>n</i> 141	161	73	150	79	<b>302</b>
Neck	% 13.2 (10.8–15.9)	15.0 (12.4–17.9)	13.6 (10.3–17.4)	13.4 (11.0–16.1)	16.4 (12.4–21.1)	<b>14.1 (12.2–16.0)</b>
	<i>n</i> 88	95	48	90	45	<b>183</b>
Mid-back	% 11.1 (8.9–13.6)	11.1 (8.8–13.7)	7.9 (5.4–11.1)	12.1 (9.8–14.7)	12.7 (9.2–17.1)	<b>11.1 (9.5–12.9)</b>
	<i>n</i> 74	70	28	81	35	<b>144</b>
Low back	% 5.5 (4.0–7.5)	8.7 (6.7–11.1)	6.5 (4.3–9.5)	7.4 (5.6–9.6)	6.9 (4.4–10.4)	<b>7.1 (5.8–8.6)</b>
	<i>n</i> 37	55	23	50	19	<b>92</b>

Key: *n*, number of participants; *F*, female; % (95%CI), prevalence (95% confidence interval); h/d, hours per day. Missing: neck pain 0.1% ( $n=1$ ), mid-back pain 0.2% ( $n=2$ ), low back pain 0.2% ( $n=3$ ), spinal pain 0.4% ( $n=5$ )

2- or 5-h sedentary time per day and moderate to severe spinal pain in boys or girls at age 11, 12 or 13 years.

From our primary analysis, estimates for the association of exceeding 2-h sedentary time per day and experiencing moderate to severe spinal pain in boys ranged from OR 0.34 (0.04–3.20) to OR 4.45 (0.24–82.23) and in girls from OR 0.36 (0.07–1.94) to OR 4.65 (0.26–82.44) (Table 2). From our sensitivity analysis, estimates for the association of exceeding 5-h sedentary time per day and experiencing moderate to severe spinal pain in boys ranged from OR 0.49 (0.14–1.65) to OR 2.15 (0.73–6.29) and in girls from OR 0.39 (0.08–1.92) to OR 1.80 (0.86–3.77) (Table 2).

## Discussion

### Key results

In this sample, regardless of sex and age, 11–13-year-old Danish adolescents who exceeded 2- or 5-h sedentary time per day outside of school did not have higher odds of experiencing moderate to severe spinal pain than those who spent less than that time. There does not appear to be a strong relationship between time spent sedentary and moderate to severe spinal pain in schoolchildren.

We found that approximately one-quarter (23.3%) of adolescents experienced moderate to severe spinal pain, with

pain in the neck and mid-back more common than low back pain. This is significant as children who report higher intensity pain (i.e. moderate to severe spinal pain) may experience a greater impact of their pain on day-to-day function than children with lower intensity pain and be at higher risk of recurrence and chronicity that extends into adulthood [5]. These findings approximate those of Joergensen et al. in a large sample from the Danish National Birth Cohort [22]. They found 30% of 11- to 14-year-olds reported moderate pain and 10% reported severe pain, with neck pain being more common than low back pain.

Our research found that this sample of 11–13-year-old Danish adolescents often exceed 2-h of sedentary time per day, and many exceed more than twice that amount (5-h per day), on weekdays and weekends. These findings are not surprising as 11-year-old Europeans spend on average 5.1–8.4 h sitting per day [23]. Actual (total) duration of sedentary time in our study is not measured, only hours outside school hours.

### Interpretation

Multiple studies have assessed the relationship between sedentary behaviours and spinal pain with inconsistent and conflicting conclusions presented in reviews of factors associated with spinal pain in children and

**Table 2** Association between exceeding 2- or 5-h sedentary time per day and moderate to severe spinal pain stratified by sex and age

	>2 hours sedentary time per day				>5 hours sedentary time per day			
	Boys		Girls		Boys		Girls	
	Count	OR(95%CI)	Count	OR(95%CI)	Count	OR(95%CI)	Count	OR(95%CI)
<b>Moderate to severe spinal pain</b>								
Weekday, outside school hours								
11y	25/168	1.47(0.41-5.31)	33/184	0.55(0.25-1.21)	9/168	1.32(0.55-3.17)	11/184	1.55(0.69-3.48)
12y	64/345	1.16(0.46-2.93)	71/326	1.01(0.46-2.25)	23/345	1.19(0.68-2.09)	26/326	1.43(0.83-2.47)
13y	43/155	4.45(0.24-82.23)	32/120	0.62(0.16-2.33)	22/155	1.96(0.96-4.00)	12/120	0.77(0.34-1.75)
Weekend day								
11y	23/168	0.59(0.20-1.78)	37/184	0.82(0.34-2.01)	10/168	0.59(0.25-1.36)	18/184	1.31(0.65-2.61)
12y	65/345	1.19(0.43-3.24)	71/326	0.93(0.42-2.08)	36/345	1.10(0.65-1.86)	38/326	1.22(0.73-2.02)
13y	42/155	2.38(0.28-20.35)	32/120	0.73(0.20-2.66)	28/155	1.45(0.70-3.01)	13/120	0.72(0.32-1.61)
<b>Moderate to severe neck pain</b>								
Weekday, outside school hours								
11y	14/169	1.18(0.25-5.53)	25/185	0.80(0.31-2.03)	5/169	1.20(0.39-3.66)	7/185	1.25(0.49-3.18)
12y	40/345	0.82(0.30-2.26)	42/328	1.91(0.56-6.51)	16/345	1.35(0.70-2.61)	14/328	1.28(0.64-2.53)
13y	27/155	2.45(0.13-45.62)	16/120	0.68(0.13-3.50)	13/155	1.55(0.67-3.57)	8/120	1.41(0.51-3.87)
Weekend day								
11y	13/169	0.58(0.15-2.22)	27/185	1.00(0.35-2.87)	6/169	0.66(0.23-1.90)	14/185	1.56(0.72-3.38)
12y	42/345	1.27(0.37-4.40)	41/328	1.26(0.42-3.76)	23/345	1.07(0.57-2.01)	25/328	1.72(0.91-3.25)
13y	27/155	3.40(0.19-61.24)	18/120	4.65(0.26-82.44)	16/155	1.03(0.44-2.39)	7/120	0.87(0.31-2.44)
<b>Moderate to severe mid-back pain</b>								
Weekday, outside school hours								
11y	12/168	2.09(0.26-16.86)	10/186	0.43(0.14-1.34)	4/168	1.20(0.35-4.09)	4/186	1.64(0.49-5.50)
12y	39/345	1.43(0.42-4.90)	32/327	0.53(0.22-1.31)	14/345	1.20(0.60-2.39)	13/327	1.42(0.69-2.91)
13y	19/155	1.63(0.09-30.67)	15/120	1.42(0.17-12.04)	10/155	1.85(0.71-4.86)	5/120	0.73(0.24-2.25)
Weekend day								
11y	10/168	0.44(0.11-1.74)	11/186	0.47(0.14-1.60)	4/168	0.49(0.14-1.65)	6/186	1.23(0.42-3.63)
12y	40/345	1.88(0.43-8.21)	34/327	0.79(0.29-2.18)	22/345	1.14(0.60-2.17)	20/327	1.39(0.71-2.72)
13y	18/155	0.83(0.09-7.30)	14/120	0.66(0.13-3.39)	14/155	2.15(0.73-6.29)	4/120	0.42(0.13-1.39)
<b>Moderate to severe low back pain</b>								
Weekday, outside school hours								
11y	10/168	0.82(0.17-4.00)	8/185	0.60(0.15-2.39)	3/168	0.88(0.23-3.39)	3/185	1.66(0.42-6.62)
12y	14/345	0.73(0.16-3.35)	28/327	0.55(0.21-1.44)	6/345	1.44(0.51-4.06)	13/327	1.80(0.86-3.77)
13y	9/155	0.74(0.04-14.38)	9/120	0.80(0.09-7.06)	4/155	1.25(0.32-4.85)	2/120	0.39(0.08-1.92)
Weekend day								
11y	10/168	0.69(0.14-3.41)	10/185	1.92(0.24-15.58)	4/168	0.55(0.16-1.92)	4/185	1.03(0.29-3.66)
12y	14/345	0.60(0.13-2.79)	27/327	0.41(0.16-1.02)	9/345	1.33(0.48-3.64)	13/327	0.78(0.37-1.61)
13y	8/155	0.34(0.04-3.20)	8/120	0.36(0.07-1.94)	4/155	0.54(0.14-2.10)	3/120	0.57(0.14-2.34)

Key: Count, adolescents who exceed sedentary time that report pain over total participants in strata; OR(95%CI), unadjusted odds ratio with 95% confidence interval; y, years. Reference category: ≤2 hours or ≤5 hours sedentary time per day. Missing: neck pain 0.1%(n=1), mid-back pain 0.2%(n=2), low back pain 0.2%(n=3), spinal pain 0.4%(n=5)

adolescents [1, 24–28]. To our knowledge, there are two other studies that report on the relationship between sedentary time and *moderate to severe* spinal pain in adolescents. Hakala et al. used multinomial logistic regression (adjusted for age and sex) in cross-sectional analysis and found adolescents who exceeded 14 h per week ( $\geq 2$  h per day) of computer use were significantly more likely to experience moderate to severe neck–shoulder pain and low back pain [29]. Hakala et al. defined sedentary time by way of computer use, whereas we combined TV, computer and other sedentary behaviours into one measure of total sedentary time. Joergensen et al. report risk estimates from uni- and multinomial regressions in cross-sectional analyses [30]. They found increasing risk of moderate and severe spinal pain with increasing screen time. The largest risk was seen in 11–12-year-olds who spent  $\geq 6$  h on screen time per day and experienced severe spinal pain. Again, Joergensen et al. assess the association of screen-based sedentary behaviours with spinal pain.

The inconsistent and conflicting conclusions seen in the literature may be explained not only by heterogeneity in methods but also by differences in the type of sedentary behaviour exposure. It may be that times spent in different sedentary behaviours have different relationships with moderate to severe pain among the three spinal regions, i.e. it may be that screen-based and non-screen-based behaviours have different effects on spinal pain risk and prognosis.

No single variable is probable to be strongly associated with spinal pain. There are likely many variables that interact along the pathway to moderate to severe pain in adolescents. It may be that there are indirect effects of sedentary time interacting with other variable/s on the pathway to spinal pain, i.e. personal or familial pain history, socioeconomic status, psychological distress, inadequate physical activity and insufficient sleep [12, 31].

### Generalisability

Caution needs to be applied when generalising our findings to other geographical regions and age groups as pain should be contextualised to cultural and sociodemographic norms [32]. Given (1) that 76% of Danish children attend public schools [33], (2) that the parental consent was passive, (3) that the participants completed the questionnaire during school hours, resulting in very high response rates, and (4) that spinal pain was only one of many domains included in the questionnaire, differential bias is unlikely and the study population is probably representative of the target population. However, the population might not be representative for the general Danish population in the age group. The schools were mainly located in small towns

because the municipalities were selected from criteria such as grade of urbanization and “move-ability” which were necessary inclusion criteria in the SPACE study [14]. We did not find any literature about adolescent spinal pain in different geographical groups or in relation to grade of urbanization, so how this might have influenced our results remains unclear.

Also, sedentary trends may have continued to change over the past decade, especially with the rapid emergence and uptake of new technologies, of which the implications are not clear [34, 35].

### Limitations

This cross-sectional study allows us to describe that we found no association between sedentary time and spinal pain in this sample. The cross-sectional nature of the data means we are unable to investigate a causal relationship with reasonable certainty. By stratifying our data by age and sex, some strata are small, reducing our confidence in estimates of association. However, this allows us to cautiously interpret where important heterogeneity among different ages and sexes may lie.

While self-reported pain measures are valid and reliable in adolescents, the same is not true for the evaluation of sedentary time. There is some ambiguity in capturing sedentary behaviours with a subjective measure as not all behaviours meet the  $< 1.5$  MET threshold for sedentary behaviour when compared to the Youth Compendium of Physical Activities [36]. For example, playing a stringed musical instrument uses 1.4 METS and therefore would be classified as sedentary. However, playing drums uses 4.0 METs and would be considered a physical activity. In future studies, a combined objective (e.g. accelerometer, inclinometer) and subjective (i.e. report on type of sedentary behaviour) measure would allow for a more accurate recording of both sedentary time and behaviour [10].

### Conclusion

In this sample, Danish adolescents aged 11–13 years who exceed 2- or 5-h sedentary time per day do not report moderate to severe spinal pain more often than those who do not. Our analysis did not consider the longitudinal or complex sequences of events necessary to address predictive or causal questions. Health behaviours established in adolescence typically predict health and health behaviours later in life [31]. It may be that excessive sedentarism over time has indirect effects or interacts with other variable/s on the pathway to spinal pain. Carefully designed longitudinal research is needed to investigate these complex relationships and assist in identifying factors predictive of spinal pain across adolescence and early adulthood.



**Authors' contributions** Conceptualisation: L Montgomery, S Kamper, M Swain. Methodology: L Montgomery, S Kamper, M Swain. Writing (original draft preparation): L Montgomery. Writing (review and editing): L Montgomery, S Kamper, J Hartvigsen, S French, L Hestbaek, J Troelsen, M Swain. Resources: J Hartvigsen, L Hestbaek, J Troelsen.

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**Availability of data and material** Access to the SPACE data analysed in the current study was provided by and is available from The Centre for Applied Research in Health Promotion and Prevention, Department of Sports and Clinical Biomechanics, University of Southern Denmark. SPACE study trial registration: [www.Controlled-Trials.com](http://www.Controlled-Trials.com) ISRCTN79122411.

**Code availability** Not applicable.

## Declarations

**Ethics approval** This retrospective study adheres to the tenets of the National Statement on Ethical Conduct in Human Research 2007 (Updated July 2018). The Science and Engineering Subcommittee at Macquarie University approved this study (Reference No: 5201831463519, Project ID: 3146).

**Consent to participate** Not applicable.

**Consent for publication** Not applicable.

**Conflict of interest** The authors declare no competing interests.

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