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Original research

The associations between organized sport participation and physical fitness and weight status development during adolescence

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ABSTRACT

Objectives: We are yet to understand how continuous participation in organized sports, dropout from organized sports, or complete non-participation affect adolescents' trajectories of physical fitness and body mass index (BMI). Thus, the aim was to examine longitudinal changes in cardiorespiratory and muscular fitness, and BMI between adolescents 1) who continued or started organized sport participation, 2) who dropped out, and 3) who never participated in organized sport or dropped out before adolescence.
Design: Longitudinal observational study.
Methods: Over four years (2017–2021), sport participation, cardiorespiratory and muscular fitness, and BMI data were collected annually from 963 participants (Mage = 11.25 ± 0.31). Latent growth curve models were utilized to examine levels (baseline) and slopes (rate of change) of BMI, cardiorespiratory, and muscular fitness in each sport participation group.
Results: Fitness levels significantly varied among groups. Continuing sport participants exhibited the highest levels, non-participants the lowest. Both groups showed significant improvements in cardiorespiratory and muscular fitness over time. Dropouts had higher baseline fitness than non-participants but demonstrated no change in cardiorespiratory fitness over time and a significantly smaller increase in muscular fitness than the two other groups. BMI increased similarly in all groups, with non-participants starting at higher baseline levels.
Conclusions: Individuals who continually participated in sports maintained higher levels of fitness than individuals who did not participate in organized sports across adolescence. However, individuals who dropped out of organized sports, showed plateau in their fitness improvements, suggesting that the physical activity previously obtained through organized sports may not be replaced elsewhere.

Practical implications

- The findings underscore the significance of encouraging ongoing participation in organized sports throughout adolescence to promote and maintain high levels of physical fitness, particularly in today's sedentary-oriented environment.
- Alternative organized options, such as after-school programs or leisure-time activities, should be offered for all adolescents, including those who drop out from organized sports and those who have never participated.
- It's important to consider that organized sports are designed to be accessible for children with lower fitness levels and higher BMI, particularly during adolescence.

1. Introduction

Regular physical activity is critical for promoting physical fitness and maintaining a healthy weight status in adolescents, which are vital for their overall health.[1] Adolescents display varying developmental patterns, with physical fitness typically showing an increase, along with BMI, while physical activity tends to decrease.[2] Participation in organized sports appears to play a critical role in promoting and shaping the developmental patterns of physical activity and fitness in youth,[3–12] while the association with weight status remains less inconclusive.[13] Despite the popularity[6] and many potential benefits, participation in organized sports declines with age.[6,14,15] Dropout accelerates in adolescence and may be attributed to various reasons, such as

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low levels of perceived competence,[14] sport-related skills and fitness.[15] The increased prevalence of dropout in adolescence[6,14,15] highlights the need for longitudinal studies to understand how both dropout and participation in organized sports are associated with the development of physical fitness and weight status across adolescence.

Previous research has mainly focused on comparing adolescents involved in organized sports with those who were not.[3–6,8–12] Consistent findings from these previous studies indicate that adolescents engaged in organized sports exhibit elevated levels of fitness and physical activity in comparison to their non-participating counterparts.[3–6,8–12] While there remains ambiguity regarding the association with weight status, with conflicting results.[4,5,9,12,13] For instance, a longitudinal study conducted by Telford et al.[3] demonstrated that children who sustained participation in sports throughout adolescence exhibited higher daily physical activity levels and better cardiorespiratory fitness compared to their non-participating counterparts. Moreover, girls affiliated with sport clubs were observed to have a lower body fat percentage.[3] However, there remains a gap in understanding the effects of dropping out of sports on fitness and weight status. Only one previous longitudinal study[16] has included participants who dropped out during adolescence, but they focused solely on differences in cardiorespiratory fitness in later adulthood. This study from Haynes et al.[16] found that men who dropped out from organized sports during adolescence exhibited significantly lower cardiorespiratory fitness at age 28 compared to those who continued participation. However, there is currently no evidence regarding the acute impact of dropout on physical fitness and weight status during adolescence. This leaves it open-ended as to whether adolescents continue to benefit from past participation in organized sports in terms of physical fitness and weight status. This is particularly interesting now in the 2020s where sedentary behaviors are becoming more of a fixture of a daily life of adolescents.[1] To address this gap, our study aimed to investigate baseline levels and slopes in cardiorespiratory fitness, muscular fitness, and weight status (specifically BMI) between three groups; those who started or continued organized sport participation throughout adolescence, those who dropped out during adolescence, and those who never participated or who dropped out before adolescence. Moreover, the influence of gender in levels and slopes was examined.

2. Methods

A total of 963 participants (Mage 11.25 ± 0.31 years) were recruited from 65 elementary schools in four cities across four out of five counties in Finland, namely South, North, Central, and East Finland. To conduct the follow-ups, most of the selected elementary schools were comprehensive schools, encompassing both elementary and middle school levels. These schools typically had between 300 and 500 students, who were predominantly of ethnically white. All chosen schools participated and were located in various areas of the city, representing a diverse student population. In each school, all 5th-grade students (ages 11 and 12) were invited to participate, achieving an 85 % participation rate. The participants represented approximately 2 % of the Finnish population in that age group.[17] We collected four-year longitudinal data on these participants from 2017 to 2021. Annually, we collected sport participation, physical fitness, and anthropometric data between August and October. However, data from only three time points (2017, 2019, and 2021) were utilized in this study. Trained researchers collected all data during school hours in the indoor gym (fitness and anthropometric measurements) and classroom (sport participation questionnaire) settings. We obtained verbal consent from the participating adolescents and written consent from their guardians before the study. The University of Jyväskylä ethics committee for human research approved the study (22082017).

Organized sport participation was assessed using a single written question: 'Do you engage in exercise or sports within a sport club?'.[18] Participants could select from four response options: 1) Yes, regularly, and actively, 2) Yes, every now and then, 3) Not anymore, but I used to, and 4) No, I don't. I have never done so. To be included in the analysis, participants had to respond at least twice across the three time points (2017, 2019, 2021). Based on their responses, we categorized participants into three groups: 1) Continued sport club participation (required at least two '1' responses, with the last response being '1'), 2) Dropout from sport club participation (required at least one '1' response and one '3' response, with the '3' response being the last one), 3) Dropped out from sport club participation prior to the study or had never participated in organized sports (required at least two '3' or '4' responses, with no other responses allowed). We labeled these groups as: 1) part-group, 2) dropout-group, and 3) non-part-group.

Cardiorespiratory fitness was measured using the 20-meter shuttle run test.[19] In this test, participants ran continuously along a 20-meter track marked out on the floor by two parallel lines 20 m apart. The frequency of recorded beeps determined the pace for each 20-meter shuttle. Starting at 8.5 km/h for the first minute, the running velocity increased by 0.5 km/h per minute. Participants ran to the beat of beeps between two parallel lines 20 m apart until they could no longer keep up. The result was the sum of completed laps.

Muscular fitness was measured using the push-up test.[20] Prior to the test, participants were instructed to take the starting position for the push-up (hands touching the floor, body, and legs in a straight line, both feet together and arms at shoulder width). Differences in push-up protocols for boys and girls were performed as in the boys' position, toes were touching the floor, whereas, in the girls' position, knees were touching the floor. Participants were instructed to complete as many push-ups as they could in 60 s by lowering the body down until there was a 90-degree angle in elbows with the upper arms parallel to the floor and keeping back straight while pushing up until the arms were straight. The result was the sum of successful push-ups in 60 s.

2.1. Anthropometric measurements

Height was measured to the nearest 0.5 cm and body weight to the nearest 0.1 kg using portable measuring equipment and calibrated scales. Participants wore light clothing and were barefoot during anthropometric testing. BMI was calculated using a formula kg/m^2.

2.2. Data-analysis

The data was screened for outliers, and we computed correlations, and descriptive statistics, including means and standard deviations for the observed variables. A multi-group parallel latent growth curve model was utilized to examine levels (baseline) and slopes (rate of change) in cardiorespiratory fitness, muscular fitness, and BMI across sport participation groups. Multi-group latent growth modeling enables comparisons of growth trajectories across groups[21] therefore providing insight into the impact of sport participation group membership on changes in physical fitness and BMI over time. As our specific interest laid in differences in baseline levels and changes over four years among sport participation groups, decision was made to include only every other time point (2017, 2019, and 2021) in the growth trajectory analysis. The loadings for BMI and cardiorespiratory fitness slopes were configured to follow a linear pattern and muscular fitness to follow a non-linear pattern. The non-linear model for muscular fitness was favored due to statistical evidence from population data (see Table 1). Specifically, we set the loadings for the first and last time points to 0 and 4, respectively, while allowing the second time point to be freely estimated. Moreover, gender was added as a covariate. Model fit was assessed using several indices: model chi-square (χ^2), root mean square error of approximation (RMSEA), Tucker-Lewis Index (TLI), comparative fit index (CFI), and standardized root mean square residual (SRMR).[22] Additionally, we conducted ANOVA with Tukey's Post Hoc analyses to examine significant differences in variable means across sport participation groups for each year. Descriptive statistics and the

Table 1
Descriptive statistics.

Measurement	Time	n	All M (SD)	Participant-group M (SD)	Dropout-group M (SD)	Non-participant-group M (SD)
BMI	2017	942	18.82 (3.07)	18.60 (2.71) N	18.67 (2.93) N	19.61 (3.90) P,D
	2019	802	20.27 (3.31)	20.03 (2.88)	20.38 (3.529)	20.70 (3.92)
	2021	559	21.43 (3.19)	21.31 (2.62)	21.49 (3.60)	21.68 (3.96)
Cardiorespiratory fitness (Laps completed)	2017	889	36.37 (18.11)	41.52 (18.62) D,N	34.63 (15.80) P,N	26.88 (14.76) P,D
	2019	719	38.26 (19.57)	45.40 (20.39) D,N	35.64 (16.71) P,N	29.84 (15.47) P,D
	2021	409	42.07 (21.36)	49.75 (21.62) D,N	34.37 (18.84) P	33.43 (18.01) P
Muscular fitness (Push-ups in 60 s)	2017	907	21.78 (12.29)	24.16 (12.06) D,N	21.79 (11.61) P,N	15.78 (11.82) P,D
	2019	797	25.70 (13.13)	29.44 (12.72) D,N	24.35 (11.91) P,N	18.17 (12.39) P,D
	2021	479	29.49 (13.36)	33.65 (12.93) D,N	25.86 (12.59) P	23.66 (11.88) P
Gender (girls/boys)	n		493/468	249/231	153/132	91/105
Gender (girls/boys)	%		51/49	51/49	54/46	47/53

Note 1. M, mean; SD, standard deviation; BMI, body mass index.
Note 2. The letters (P = participant-group, D = dropout-group, N = non-participant-group) indicate the profiles between which there is a significant difference $p < 0.05$.

Missing Completely at Random (MCAR) test were performed using SPSS 26.0 and Mplus Version 8.6 was used for model estimation.

3. Results

Distribution of participants across groups and, descriptive statistics for each measurement are presented in Table 1. All groups were predominately equal in gender. The correlations between BMI, cardiorespiratory, and muscular fitness were significant (see Table 2). BMI was negatively correlated with cardiorespiratory and muscular fitness.

Since the annual completion rate decreased, 25 % of the data consisted of missing values (2164 out of 8667). Participation was voluntary, and all participants were given the opportunity to participate each year. However, their willingness to participate decreased, as they aged. The Missing Completely at Random (MCAR) test suggested non-randomness ($\chi^2(615) = 535$, $p < 0.05$), and further examination revealed no specific group attributing to the missing values. Hence, we assumed missing values to be Missing at Random (MAR) and assessed them using a mixture likelihood procedure, which has been shown to generate reliable parameter estimates and standard errors under MAR conditions.[23]

We estimated a multi-group parallel latent growth curve model to examine levels and slopes of BMI, cardiorespiratory fitness, and muscular fitness simultaneously in the three sport participation groups. Overall, there was a good model fit with all indices meeting acceptable criteria ($\chi^2 = 177.157$, $p < 0.001$; Root Mean Square Error of Approximation (RMSEA) = 0.063, 90 % Confidence Interval (C.I.): 0.051–0.075; Comparative Fit Index (CFI) = 0.967; Tucker-Lewis Index (TLI) = 0.943; Standardized Root Mean Square Residual (SRMR) = 0.053).

The results indicated significant differences in baseline cardiorespiratory and muscular fitness levels among all three groups, as presented in Table 3, along with the covariate effect of gender. Adolescents in the part-group exhibited the highest baseline levels of cardiorespiratory and muscular fitness. Adolescents in the dropout-group had the second highest baseline levels of cardiorespiratory and muscular fitness, while adolescents in the non-part group had the lowest baseline levels. Furthermore, the baseline level of BMI was significantly higher within adolescents in the non-part-group compared to their peers in the other two groups.

Both adolescents in part-group and non-part-group showed positive and significant slopes in cardiorespiratory fitness (see Table 3).

Table 2
Correlations between variables each year.

	Time	Cardiorespiratory fitness	Muscular fitness
BMI	2017	−0.456***	−0.290***
	2019	−0.423***	−0.280***
	2021	−0.327***	−0.178***
Cardiorespiratory fitness	2017		0.437***
	2019		0.456***
	2021		0.419***

Note 1. BMI, body mass index.
Note 2.
*** $p < 0.001$.

Table 3
The parameter estimates for latent growth curve models of each participation group and the covariate effect of gender.

		Participation (P)	Dropout (D)	Non-participation (N)
Cardiorespiratory fitness	Level (SE)	41.45 (0.83)*** (D, N)	34.74 (0.92)*** (P,N)	26.84 (1.03)*** (P,D)
	Slope (SE)	1.54 (0.29)*** (D)	−0.23 (0.40) (P,N)	1.27 (0.39)*** (D)
Muscular fitness	Level (SE)	24.02 (0.53)*** (D, N)	21.77 (0.70)*** (P,N)	15.74 (0.76)*** (P,D)
	Slope (SE)	2.40 (0.19)*** (D)	1.06 (0.23)*** (P,N)	1.97 (0.27)*** (D)
BMI	Level (SE)	18.60 (0.12)*** (N)	18.68 (0.17)*** (N)	19.59 (0.28)*** (P,D)
	Slope (SE)	0.73 (0.03)***	0.76 (0.04)***	0.70 (0.08)***
Gender ON cardiorespiratory fitness	Level (SE)	−10.64 (1.65)***	−7.05 (1.90)***	−2.31 (0.26)
	Slope (SE)	−0.70 (0.23)	−0.86 (0.78)	−1.13 (0.76)
Gender ON muscular fitness	Level (SE)	7.38 (1.04)***	8.21 (1.27)***	9.58 (0.1.53)***
	Slope (SE)	−2.28 (0.37)***	−2.13 (0.47)***	−2.08 (0.54)***
Gender ON BMI	Level (SE)	0.02 (0.12)	0.13 (0.71)	−0.62 (0.56)
	Slope (SE)	0.12 (0.03)*	0.07 (0.07)	0.06 (0.12)

Note 1. SE, standard error; BMI, body mass index.
Note 2. The letters (P = participation, D = dropout, N = non-participation) indicate the profiles between which there is a significant difference $p < 0.05$.
Note 3. Gender (boys = 0, girls = 1).
Note 4.
*** $p < 0.001$.
* $p < 0.05$.

Furthermore, there was no significant difference in the slopes between these two groups, indicating that the rate of increase in cardiorespiratory fitness over time was similar, resulting in the persistence of relatively large differences through adolescence. Among adolescents in the dropout-group, the cardiorespiratory fitness slope was not significant, indicating no significant change in cardiorespiratory fitness over four years. At the final time point (2021), there were no significant differences in the mean values of cardiorespiratory fitness between adolescents in dropout- and non-part-groups.

The slopes of muscular fitness showed positive and significant changes in all three groups. However, the rate of change was significantly lower among adolescents in dropout-group compared to their peers in the other two groups (see Table 3). Consequently, at the final time point (2021), there were no significant differences in the mean values of muscular fitness between dropout- and non-part-groups. The slopes of BMI were positive and significant in all three groups, indicating an increase in BMI over time. Importantly, there were no significant differences in slopes between the groups, suggesting a similar rate of change across adolescents in all groups (see Table 3).

The covariate analysis of gender revealed that girls demonstrated significantly lower baseline levels of cardiorespiratory fitness in the participation- and dropout-group compared to boys, but there were no differences in slopes. Moreover, girls showed higher baseline levels but significantly smaller improvements in muscular fitness compared to boys. However, this needs to be interpreted with caution as the measurement protocol for muscular fitness differed between boys and girls.

4. Discussion

Our study aimed to examine the association of sport participation with the development of cardiorespiratory and muscular fitness and BMI across adolescence. Adolescents engaged in organized sports displayed higher cardiorespiratory and muscular fitness levels compared to their non-participating peers over time. However, our findings indicated that adolescents who dropped out from organized sports did not demonstrate any change in cardiorespiratory fitness over time, unlike those who continued participating or those who had not engaged in organized sports across adolescence. The trend was similar for muscular fitness. Although adolescents who dropped out from organized sports demonstrated a positive slope, it was significantly smaller than their peers in two other groups. While BMI increased at a similar rate for all adolescents, those not participating in organized sports had the highest baseline level. There were significant differences in baseline levels of cardiorespiratory fitness observed between genders among those who continued participating and those who dropped out.

Consistent with previous studies, our study confirmed that adolescents who engaged in organized sports had significantly higher baseline levels of cardiorespiratory[3,5,8,9] and muscular fitness[7] compared to their non-participating peers. This can be attributed to the higher levels of moderate and especially vigorous physical activity observed among adolescents participating in organized sports.[6] Physical fitness levels, particularly cardiorespiratory fitness, can indicate moderate-to-vigorous physical activity levels over the past few months because they reflect the physiological response to physical activity habits.[7,24] However, the associations between organized sports and physical fitness may be bidirectional, as demonstrated in a study by Cairney & Veldhuizen.[12] Genetic factors and previous physical activities also influence physical fitness[24,25]; therefore, adolescents with higher fitness levels might be more willing to participate in organized sports due to their enhanced abilities.[26]

While previous studies have typically focused on differences in physical fitness between adolescents who participate in organized sports and those who do not,[3,5,8,9] our study also included those who dropped out during adolescence. Notably, our results showed that adolescents who dropped out had significantly lower baseline levels of both cardiorespiratory and muscular fitness compared to their peers who continued participating in organized sports over time. A recent study[27] found that adolescents with higher levels of cardiorespiratory fitness at the age of 14 were more likely to participate in organized sports at the age of 19. Thus, aligned with study from Moa et al.,[27] our result with early adolescent sample suggests that a higher level of fitness may promote sustained engagement in organized sports, potentially due to the association between physical fitness and perceived competence, which is related to longitudinal engagement in physical activities.[28] Conversely, a lack of physical fitness and perceived competence are significant reasons for dropping out of organized sports.[14,15]

Although we found significant differences in baseline levels of physical fitness among all sport participation groups, the rates of changes in cardiorespiratory and muscular fitness over time were significantly different only between the dropout-group and two others. The part-group and non-part-group showed similar increases in their cardiorespiratory and muscular fitness over four years, indicating that their differences remained large over time. During adolescence, in addition to maturation and growth,[25] cardiorespiratory and muscular fitness can be enhanced through vigorous physical activity,[7,29] which is typically more prevalent among adolescents engaged in organized sports.[6,30] However, since we observed no difference in the rates of improvement, but a significant difference in the baseline levels between participating and non-participating adolescents, this could indicate that the observed polarization in cardiorespiratory and muscular fitness occurs earlier in childhood and may be driven by both previous physical activity[24] and genetics.[25] Similarly, Telford et al.[3] found no significant differences in the cardiorespiratory fitness development between organized sport participants and non-participants, although the levels were different. However, in their study,[3] while overall physical activity decreased during adolescence, organized sport participants maintained higher cardiorespiratory fitness. This, together with our findings suggests that organized sport may help sustain higher physical fitness by facilitating vigorous physical activity,[6,30] even as total physical activity declines in adolescence.[3]

Adolescents in the dropout group exhibited no change in cardiorespiratory fitness and a smaller increase in muscular fitness over four years compared to their peers in other groups. A fundamental principle of physical activity training is the progressive loss of beneficial training effects, such as improved fitness, when the duration, frequency, and especially intensity of training are reduced.[31] Although, adolescents participating in organized sports generally engage in higher levels of physical activity,[4,6] a recent study[30] revealed that most adolescents who participated in organized sports accumulated more physical activity only on training days than non-participants. Therefore, our study suggests that as adolescents drop out from organized sports, their duration, frequency, or intensity of physical activity training is reduced. Importantly, the previously accumulated physical activity from organized sports may not be replaced elsewhere, leading to a plateau in physical fitness. Recognizing the critical role of adolescent participation in organized sports in promoting physical fitness and lifelong physical activity habits, organized sports should be considered a valuable strategy for health promotion.

Studies examining the role of organized sports in weight status have yielded inconsistent findings.[13] In our study, baseline BMI was significantly higher in the non-participation group, which aligns with findings from Cairney & Veldhuizen[12] and Drenowatz et al.[5] However, this contrasts with other studies that did not find associations between sport participation and BMI.[4,9] Cairney & Veldhuizen[12] suggested a bidirectional relationship between BMI and sport participation. While increased physical activity may lead to a smaller BMI in adolescents, higher BMI levels might hinder participation in organized sports due to lower fitness and perceived competence.[28] Notably, we found no significant differences in BMI development between groups, indicating limited impact of organized sports on BMI development during adolescence. This could be due other factors, such as sleep and eating behaviors, which may have a more substantial effect on BMI than sport participation alone.

Our results indicated overall a similar proportion of both genders in all groups. Notably, girls exhibited significantly lower baseline levels of cardiorespiratory fitness at the age of 11 in all groups, except in non-participants. This suggests that, in comparison to participating girls, boys engaged in organized sports may have higher physical activity levels, as demonstrated by Telford et al.[3] Contrary to previous findings[25] indicating steeper cardiorespiratory fitness slopes in boys, no gender differences in slopes were observed in this study. This suggests that the development of cardiorespiratory fitness was similar for boys and girls across all groups, maintaining the initial differences between genders. Significant gender differences were observed in both levels and slopes of muscular fitness across all groups. Girls consistently demonstrated higher baseline levels but showed less improvement compared to boys. The variations in baseline levels may stem from differences in the measurement protocol for boys and girls, while differences in slopes are likely influenced by maturation.

Our longitudinal study had a unique design to study the influence of sport participation on the development of BMI and physical fitness in adolescents. Although our study had a large number of participants around Finland, which promotes generalizability of the study's findings, there may be differences in sport participation between countries. Our analysis lacks information on when adolescents dropped out from organized sports, which could have provided more accurate insights into the influence on BMI and physical fitness development. Moreover, our study does not provide information on the development of physical activity, specific sports practiced, training frequencies, intensities, or durations that could significantly influence the development of physical fitness. Due to a decision to use only three groups and missing data, sport participation status should be addressed cautiously. For example, the part-group included adolescents who may have participated through all four years and those who may have participated just the last two. Similarly, in the dropout-group, adolescents may have participated in organized sports varying years before dropping out. Furthermore, the use of a questionnaire to estimate sport participation may be susceptible to social desirability bias or other forms of reporting biases. Finally, BMI cannot differentiate between fat and fat-free mass, making it less accurate for assessing athletic populations.

5. Conclusion

Our study provides novel findings of the influence of organized sport participation on BMI, cardiorespiratory fitness, and muscular fitness among adolescents. Our study suggests that adolescents do not benefit from their past organized sport participation in terms of physical fitness, but that the fitness improvements are diminish with dropout. Continued participation in organized sports through adolescence is an important avenue to help increase and maintain high physical fitness, particularly in our current sedentary-oriented environment. Therefore, meaningful, fun, motivating, low-cost and low-threshold organized physical activities should be funded and promoted in sport clubs and after-school programs to improve adolescents' physical fitness and thus enhance their overall health.

CRediT authorship contribution statement

IK conducted the research, wrote the manuscript, analyzed data, and interpreted results. DS and AG contributed to writing and interpreting. MH aided in research design and provided manuscript feedback. TJ, the principal investigator, oversaw the project, contributed to design, and participated in writing.

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Confirmation of ethical compliance

We obtained verbal consent from the participating adolescents and written consent from their guardians before the study. The University of Jyväskylä ethics committee for human research approved the study (22082017).

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT 3.5 in order to check and improve the language and readability. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of interest statement

The authors declare no competing interests.

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