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Are children participating in a quasi-experimental education outside the classroom intervention more physically active?

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Abstract

Background: Education outside the classroom (EOTC) is a curriculum-based approach to teaching that has shown positive associations with children's physical activity and academic learning in small-scale case studies. The purpose of this large-scale quasi-experimental study was to determine if children who participate regularly in EOTC spend more time being physically active than children who do not.

Methods: In the 2014/2015 study TEACHOUT, classes were recruited in pairs such that each EOTC class had a non-EOTC comparison class at the same school and grade level. Participants in 17 EOTC classes and 16 comparison parallel classes across Denmark wore an Axivity AX3 accelerometer taped to the lower back for seven consecutive days. Data from 201 EOTC participants (63.3% girls, age 10.82 ± 1.05), and 160 comparison participants (59.3% girls, age 10.95 ± 1.01) were analysed using an 'intention to treat' (ITT) approach. The amount of EOTC the participants were exposed to was monitored. Associations between time spent in different physical activity intensities and EOTC group and sex were assessed using generalised linear models adjusted for age. In a second analysis, we modified the sample using a 'per protocol' (PP) approach, only including EOTC and comparison class pairs where the EOTC class had >150 min and the comparison had <150 min of EOTC during the measured week.

Results: On average, EOTC participants spent 8.4 (ITT) and 9.2 (PP) minutes more in moderate-to-vigorous physical activity (MVPA) per day than comparison participants ($p < 0.05$). However, EOTC boys spent 18.7 (ITT) and 20.8 (PP) minutes more in MVPA per day than comparison boys ($p < 0.01$), while there were no significant between-group differences for girls.

Conclusions: For boys, EOTC was associated with more daily time being spent moderately and vigorously physically active. No differences were observed for girls. Implementing EOTC into schools' weekly practice can be a time- and cost-neutral, supplementary way to increase time spent in PA for boys through grades three to six.

Trial registration: The Scientific Ethical Committee in the Capital Region of Denmark protocol number H-4-2014-FSP. 5 March, 2014.

Keywords: Accelerometry, Active learning, Active living, Health promotion, Learning outside the classroom, Outdoor teaching, Physical activity, Prevention, School-based intervention, School health

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Background

Regular physical activity (PA) in children is essential for reducing a number of physiological risk factors [1, 2], and can improve cognitive performance [3, 4], academic achievement [5, 6], and mental health [7–9]. Nonetheless, surveys in Denmark and other western countries have consistently reported that a large proportion of children do not achieve the recommended daily minimum of 60 min of moderate-to-vigorous physical activity (MVPA) [1, 10].

Schools are an important setting for promoting children's daily PA, as children spend a large proportion of their waking hours at school, and children from all socio-economic and cultural backgrounds can be reached [11]. WHO's Health Promoting Schools framework was developed in the late 1980's as a holistic approach to improve the health of children and adolescents. A recent meta-analysis [12] found trials adhering to the Health Promoting School's framework to provide small positive effects on health parameters, including PA, that are potentially important at population level. However, a common barrier to the implementation and success of school-based PA promotion initiatives is that they are often 'add-on' or extra-curricular activities that are assigned a lower priority than schools' primary educational objectives [13, 14]. It is therefore probable that PA promoting activities that overtly align with or support children's learning activities may be more effective in engaging school staff and achieving their educational goals.

Education outside the classroom (EOtC) [15, 16] is an example of an 'add-in' learning strategy that has been shown to change the setting and make it possible for participants to obtain higher PA levels while learning academically [17, 18]. In the past decade, EOtC has gained increased political interest [16], and the practice has become common in Scandinavia [19]. Two Scandinavian studies [20, 21] observed higher amounts of PA on days where school children participated in EOtC activities; however, research linking EOtC and PA has been limited to case studies with small numbers of classes and participants. Larger quantitative studies investigating the influence of EOtC on children's daily PA are needed to guide future policy decisions in education and health promotion in schools. Thus, the purpose of this large-scale quasi-experimental study was to determine if children who participate regularly in EOtC spend more time being physically active than children who do not.

Methods

Study design and setting

This study is part of the larger Danish TEACHOUT study. TEACHOUT is a mixed methods, quasi-experimental,

cross-disciplinary study that aims to understand how regular EOtC influences PA, learning, social relations, motivation, and well-being among school participants attending grades three to six (9–13 years old). Within the Danish school setting, each school is allowed so-called "freedom of methods" to align with ministerial-decided curricula targets for each subject [22]. In August 2014, a range of initiatives was implemented with a new public school reform. Some of these initiatives were requirements for 1) children and school staff to stay at the school for between 5.5 and 8.5 h more per week than before the reform depending on grade level, 2) the provision of 45 min of daily PA on average for children, 3) schools to engage in more cooperation with the local community, and 4) teachers to increase child participation in educational activities [22]. In the Danish school system, participants in each school district are randomly assigned to a class when entering the school system at grade 0, such that participants in parallel classes should be comparable in demographic characteristics [23]. Intervention (i.e. EOtC) and comparison classes were not randomised, but assigned by the participating class teacher's willingness to participate in a particular group. Class pairs were required to be at the same grade level and school.

Education outside the classroom

EOtC targets primary school children and is characterised by regular curriculum-based educational activities practiced outside the school buildings (i.e. one day weekly or fortnightly) in natural (e.g. a park or forest) or cultural (e.g. a museum or library) settings [19, 24]. EOtC has typically been practiced in natural settings with the aim to teach abstract academic skills and concepts in a more hands on and illustrative way. Examples could be measuring and calculating a tree's volume in Math, teaching language skills through poem writing in and about nature, and teaching history or religion while visiting places of historic significance [16]. The program theory proposed to explain effects on participating children seen as a consequence of EOtC practice involves changing the physical setting to allow for different use of pedagogies, such as inclusion of more movement, play, use of senses, problem solving, experimentation, and cooperation [25]. This way, EOtC is proposed to provide a motivating school setting that facilitates learning processes in children. More information is accessible regarding the rationale and design of the TEACHOUT study [25] and provision of EOtC practice across Danish schools just prior to our data collection, in terms of occurrence, frequency and location [26].

Prior to the intervention year, participating EOtC teachers were invited to a two-day seminar, which was attended by 15 of 17 EOtC teachers in TEACHOUT. The seminar included workshops about EOtC as teaching

method, organized networking sessions in groups, and more in-depth information about the study. Each participating teacher was given two gift cards of 500 DKK (~67 €) during and at the completion of the study to show appreciation for their substantial efforts.

EOTC class teachers were asked to provide the class with an average of at least 300 min of EOTC practice through one or two weekly sessions during the full school year. Comparison class teachers were asked not to regularly practice EOTC with the class. The 300 min weekly EOTC minimum was selected so that it was a substantial contributor to children's school time and to separate the practice from occasional field trips. Teachers were instructed to include time spent on briefing before and de-briefing after the educational activities outside the school's buildings when reporting minutes of EOTC practice.

Participants

Inclusion criteria for classes were 1) grades three to six, 2) at least two classes in the same grade level and school, and 3) implementation of EOTC at least 300 min per week (on average) in only one of the two classes but not the other. All children in participating classes were regarded eligible for inclusion, except if they had known tape/band aid allergy. Potential participating classes were recruitment through contacting schools, and schools were identified in three ways. First, 290 Danish schools who reported that they implemented EOTC in a national survey [19] were contacted directly. Second, we contacted all municipalities in Denmark to gather information on which of their schools were known to practice EOTC, and to obtain permission to contact these schools. Third, we used our professional networks to contact schools and teachers practicing EOTC. In total, 549 of 1313 Danish schools were contacted. Twelve schools met the inclusion criteria and agreed to participate in the project comprising 17 EOTC classes totaling 346 participants and 16 comparison parallel classes totaling 317 participants. One "pair" included three classes in the same grade level and school of which two practiced EOTC together and the third acted as comparison class. This explains the uneven number of EOTC and comparison classes. Reasons for the low participation rate of schools included being unable to provide a comparison class, only having one class at the same grade level, lacking time or willingness to participate (often with the new school reform as reason), and comparison teachers deciding to practice EOTC anyway.

Data collection and measurements

The data collection was cross-sectional with all class pairs measured once between November 2014 and April 2015. On average, data from 5.5 ± 2.1 classes were

collected per month during the six months of data collection. Each participating class pair was visited simultaneously at their school and given oral information about the protocol together in their class pair. Each child reported birthdate, sex, and had their height measured in cm (Leicester Height Measure) and weight in kg (OMRON BF212 Body Composition Monitor). BMI percentile were calculated using height, weight and age information as described by Barlow and Dietz [27]. A participant was regarded overweight if BMI percentile was more than 85 percentile and obese when higher than 95 percentile [27]. Participants in each EOTC and comparison parallel class pair were asked to wear an accelerometer in matching periods going from Monday or Tuesday to the following week's Thursday or Friday. Anthropometric measurements and attachment of accelerometers was performed individually in a separate room on the day of setup. Figure 1 shows the monthly distribution of measurements by number of classes, number of children within the classes and number of children with valid PA data.

Physical activity measurements

Each participant had an Axivity AX3 triaxial accelerometer (Axivity, Newcastle, UK) tape-mounted to the skin of the lower back. Accelerometers were initialized to measure raw accelerometry and temperature data at 30 Hz with $\pm 8G$ bandwidth and data stored in the binary .gt3x ActiLife file format. The accelerometer was placed above the upper point of the posterior iliac crest to the right side of the spine with the positive x-axis pointing downward and negative z-axis pointing forward. The accelerometer was tape-mounted using a four step protocol. First, the skin was cleaned using an alcohol wipe. Second, a 3*5 cm piece of Fixomull tape (BSN Medical) with a 1*2 cm piece of double sided adhesive tape (3 M, Hair-set) on top was placed on the skin. Third, the accelerometer was attached to the double sided adhesive tape. Fourth, an 8*10 cm piece of Opsite Flexifix (Smith & Nephew) with rounded corners was placed on top. The participants were instructed to wear the accelerometer at all times, including sleep and water activities, and not to put the accelerometer back on if it detached before the planned end of measurements.

Processing of accelerometer data

Participants were included in the study if they had accumulated continuous accelerometry data for seven days with 24 h per day, starting at midnight on the end of the day the participant had the accelerometer mounted. The inclusion criteria of seven full days of 24 h continuous wear time was chosen to enable comparisons of the effect on PA of between EOTC and comparison groups with no need to weight the amount of EOTC between

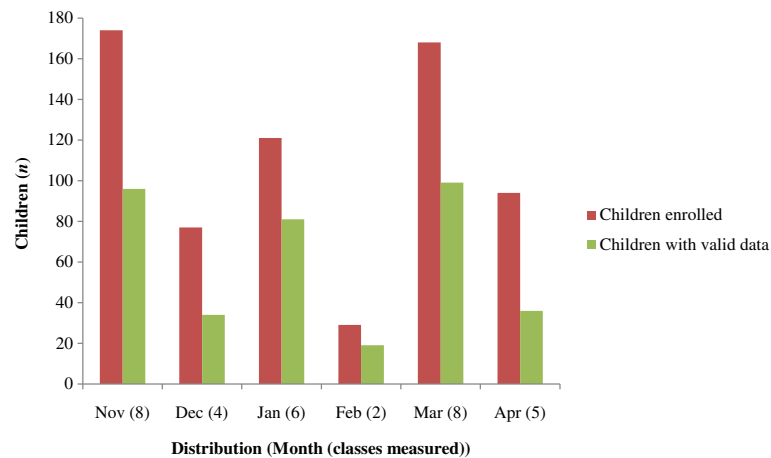


Fig. 1 Distribution of measured classes and participants segmented into months. Children enrolled refers to children with informed consent obtained. Children with valid data refer to the number of children adhering to a seven days of 24 h accelerometer wear time inclusion criteria for PA measurement

participants that had different number of days of measurements, and to ensure a high data validity by capturing all movements throughout the day, eliminating missing data, and minimizing the uncertainties caused by day-to-day variation. Wear time was determined using a specific algorithm for raw accelerometry and temperature data. The .gt3x files were then transformed into 15 s epoch length .agd files using ActiLife (version 6.11.8) and categorised in four activity intensity levels, light physical activity (LPA), moderate physical activity (MPA), vigorous physical activity (VPA), and combined moderate and vigorous physical activity (MVPA) using the cut points defined by Evenson (2008) [28]. See Schneller et al. [29] for more information on how PA data was collected and processed in the TEACHOUT study.

Exposure to education outside the classroom

Information on the amount of EOTC practiced in each class during the five school days of PA measurements was collected through class level diaries on school time activities and an online EOTC monitoring tool. The monitoring tool was an internet-based reporting system that required a teacher from each participating class to provide daily information throughout the school year about their EOTC practice. Class diaries included a separate table for each school day during the data collection period. The teacher of each class was asked to select three responsible children in their class with whom they in cooperation completed it with. The combined information from the diaries and EOTC monitoring reporting's enabled us to determine how much EOTC was actually done by each class. Our intention with combining the class diary and monitoring tool information was two-fold: 1) to check if matching information was provided on EOTC within the same class during the measured week and 2) to determine whether the difference

in weekly minutes of EOTC practice between EOTC and comparison groups during the measured week was representative of the practice occurring throughout the school year. We conducted an 'intention to treat' analysis (ITT) for all included participants in all class pairs, no matter how much EOTC they were exposed to during the period and a per protocol analysis (PP) with a 150 min EOTC threshold. This threshold meant that only class pairs where the EOTC class had at least 150 min of EOTC and the non-EOTC class had less than 150 min of EOTC during the week of measurement were included. The ITT sample included 361 participants and the PP sample 258 participants.

Statistical analysis

Differences in characteristics between participants who were and were not included in the analysis, and between the EOTC and comparison groups, were assessed using independent-samples t-test, Pearson χ^2 cross tabulation test, or Fischer's exact test (due to low number of obese cases). In both the ITT and PP analyses, associations between time spent in the different activity levels and group and sex (and their interaction) were assessed using generalised linear models (normal distribution with an identity link) adjusted for age. Significance levels for all post-hoc pairwise comparisons were adjusted for the effect of multiple testing using the Bonferroni correction method. Significance level was set to $p < 0.05$. All statistical analyses were conducted using Stata 14 and SPSS 23 statistical software.

Ethical considerations

Parents or legal guardians of all participants received oral and written information about the study content and provided informed consent on behalf of their child prior to participation. A female researcher conducted

anthropometric measurements and attached accelerometers on girls in one room and a male researcher did the same on boys in another room.

Results

Table 1 shows the participating schools' characteristics in terms of size and geographic and economic resources. Schools varied in number of children attending, population density within the local area, as well as access to green spaces due to their diverse location in both rural and urban areas across Denmark.

Table 2 shows compliance to the PA measurement inclusion criterion and quantified reasons for non-wear. A higher proportion of children in the comparison group had invalid measurements and more of these cases were unaccounted for compared to the EOTC group. See Schneller et al. [29] for more details regarding PA measurements.

Tables 3 and 4 shows the characteristics of participating school classes in total and grouped as EOTC and comparison classes, and the characteristics of included and excluded participants as well as the included participants in the EOTC and comparison groups for the ITT and the PP analysis, respectively.

Participants in the EOTC group were exposed to significantly more EOTC than the comparison group in both samples. In the PP sample, significantly more EOTC classes fulfilled the minimum criterion of 300 min of practiced EOTC compared to the comparison classes. Similar differences in number of classes fulfilling the minimum 300 min EOTC criterion were observed in the ITT sample, although they only approached significance ($p = 0.065$). For both the ITT and the PP sample, included participants were, on average, significantly younger, more likely to be girls, lower in BMI and BMI percentiles, and less likely to be overweight or obese when compared to excluded participants. No significant difference was found on group level in the proportion of EOTC participants comparing included and excluded participants in either the ITT or the PP sample. Included participants in the EOTC and comparison group did not differ significantly in age, sex, BMI, BMI percentile, or frequency of overweight/obesity in either sample.

In all generalised linear models, significant effects of group, sex, group by sex, and age were observed. No significant interactions between age and group were detected and this interaction term was subsequently excluded from the final models. Figure 2 (ITT sample) and Fig. 3 (PP sample) shows the estimated marginal means for the time spent in different physical activity intensities by group (EOTC vs comparison) and sex, after adjustment for age.

Table 5 shows the estimated marginal means for daily minutes spent in MVPA, VPA, MPA, and LPA for EOTC vs comparison, boys vs girls, EOTC vs comparison for boys only, EOTC vs comparison for girls only, and age. In both the ITT and the PP analyses, EOTC participants spent more daily minutes in MVPA, VPA and MPA than comparison participants, although the difference for MPA in the PP analysis only approached significance. No differences were found for LPA between EOTC and comparison groups. In both analyses, boys in the EOTC group spent more minutes in MVPA, VPA and MPA per day than boys in the comparison group, while no differences were found for LPA. Girls in the EOTC group did not spend a significantly different amount of daily time in MVPA, VPA, MPA, or LPA compared to girls in the comparison group. Finally, a significant inverse association was detected between a one year increase in age and daily time spent in MVPA, VPA, MPA, and LPA (i.e., activity declined with age).

Discussion

A previous review suggested that the inconsistent effects of school-based interventions on children's PA may be caused by variation in the implementation of the interventions [30]. Our results suggest that aligning the core mandates and curriculum-based obligations of a teacher with EOTC is a viable way to implement and thereby increase PA for boys in grades three through six. Furthermore, the intervention was implemented with low cost and effort, as the two-day seminar on EOTC practice was the only component of the intervention that required allocation of additional time and money. Otherwise, the intervention was designed to be time- and cost-neutral throughout the school year. We found no significant

Table 1 Description of size and geographic and economic resources of the 12 included schools

	Range	Mean \pm SD	Median
Number of students	226–2002	770 \pm 439	710
Average household income in DKK	561,440–834,359	683,689 \pm 78,100	662,640
Number of households within 10 km*	6567–609,486	138,042 \pm 222,131	41,594
Distance (meters) to the nearest green space	45–737	325 \pm 200	266
Square meters of green space within 10 km*	154,826–17,339,806	2,387,000 \pm 4,811,834	718,485
Number of green spaces within 10 km*	8–53	26 \pm 14	23

Green space includes parks, woodlands, nature areas and heathlands registered in the official land use database of The Danish Geo-data Agency. *of the school

Table 2 Physical activity measurement compliance

	EOTC, n (%)	Control, n (%)
Participants	346 (100.0)	317 (100.0)
Valid PA measurements	201 (58.1)	160 (50.5)
Invalid PA measurements	145 (41.9)	157 (49.5)
Accelerometer not returned	12 (3.5)	14 (4.4)
Technical error	10 (2.9)	2 (0.6)
Deliberately removed	18 (5.2)	24 (7.6)
Fallen off	28 (8.1)	25 (7.9)
Unknown if deliberately removed or fallen off	77 (22.3)	92 (29.0)

Valid PA measurements required continuous accelerometer data for seven days with 24 h of wear time per day, starting at midnight on the end of the day the participant had the accelerometer attached. The reason for non-compliance was considered due to a “technical error” if a data file was shorter than the required inclusion period and the accelerometer was still worn at the last time stamp included in a data file. The category “deliberately removed” included reasons such as experiencing a rash at the attachment site and removal of accelerometer due to sports competition. The category “Fallen off” included failing adhesion between tape and skin and accelerometers getting knocked loose by mechanical interference from an external source.

interaction between age and group, which indicates that EOTC had a positive impact on MVPA even for the older children, who are generally considered less active than younger children [31, 32]. However, it should be noted that PA still declined with age for both groups; a finding already well-established in the literature [31, 32].

While our findings suggest that EOTC may be a cost-effective, supplementary strategy for creating a more active and varied school day, boys spent approximately double the amount of time in MVPA compared to girls in the EOTC group, suggesting that EOTC may contribute to the gap in levels of PA between sexes that is already well established in the literature [32–34]. This gap between sexes increases during the transition from childhood to adolescence as girls’ MVPA declines more, with onset at younger age and from a lower starting point at onset, compared to boys’ [35]. In addition, findings from meta-analyses of the effectiveness of interventions targeting PA promotion in girls [36, 37] showed positive, but small, effects. This indicated that affecting behaviour change in the form of higher levels of PA is challenging in these groups. The same meta-analyses reported lower effectiveness of long-term implementation for girls of increasing age, indicating a need to develop interventions that provides positive and sustainable effects on girls’ PA behaviour starting from an early age [36, 37].

The greater effect of EOTC among boys is in line with research showing that the largest sex differences in children’s PA levels are seen in institutional contexts for self-organised PA compared to adult-led and structured activities, such as organised sport and PE [38]. Similarly, a qualitative study of lived experiences set within an intervention aiming to increase PA during recess,

concluded that the least active children increased recess PA through the inclusion of teacher-led play, but not free play [39]. Generally, boys’ motivation for engaging in PA is intrinsic and girls’ to a larger extent driven by both intrinsic and extrinsic motivation [40]. Having a teacher to create a social and supportive environment in which children are asked to engage in PA may therefore increase the extrinsic motivation for girls to be active. A large proportion of the least active children are girls in our study, and girls as group therefore could benefit more from adult-structured activities aiming to increase PA, such as PE or activities specifically aiming to integrate PA into school time [41].

During EOTC, the primary aim and the primary activities are not PA per se [15–17]; however, the outdoor environment and the structure of the teaching do provide children with more opportunities for being physically active of their own accord than the indoor classroom [20, 21]. A recent study in Australian children found that living in neighbourhoods with more green space was associated with higher odds of choosing physically active pastimes and lower odds of not enjoying PA for boys but not for girls [42]. In our study, EOTC was often practised in green areas in the participants’ neighbourhood, which, in part, might explain the different effect on MVPA found between boys and girls. On this basis, we hypothesize that the opportunities provided for engaging in PA by the current EOTC practice in Denmark are mainly self-structured and therefore better suited to boys’ tastes, abilities, values, and motivation regarding physical activities. However, the previously mentioned meta-analyses targeting effectiveness of interventions on girls’ PA also showed that targeting multiple components, e.g. education and a change of environment, resulted in larger effect sizes [36, 37]. As such, a teacher instructing EOTC activities that specifically include sessions of activities with PA at a location providing better opportunities for PA than the classroom, might lead to positive effects of implementing EOTC practice on girls’ PA. Future analyses of PA segmented into domains, i.e. time spent in EOTC, recess, PE, and leisure time, and collecting qualitative data may provide a deeper understanding of how PA is accumulated for boys and girls engaging in EOTC practice.

The present study was the first quantitative, large-scale, controlled study investigating the effect of EOTC on PA. Strengths of the study included 1) parallel class design to obtain pairs for comparison that were alike regarding personal characteristics, 2) monitoring of EOTC practice to determine intervention fidelity and facilitate statistical analyses on both an ITT and a PP sample, and 3) valid and objective PA measurements using a strict inclusion criteria of seven days of 24 h measurements per participant. Limitations were that 1) we were unable

Table 3 Class and participant characteristics, 'intention to treat'-analysis

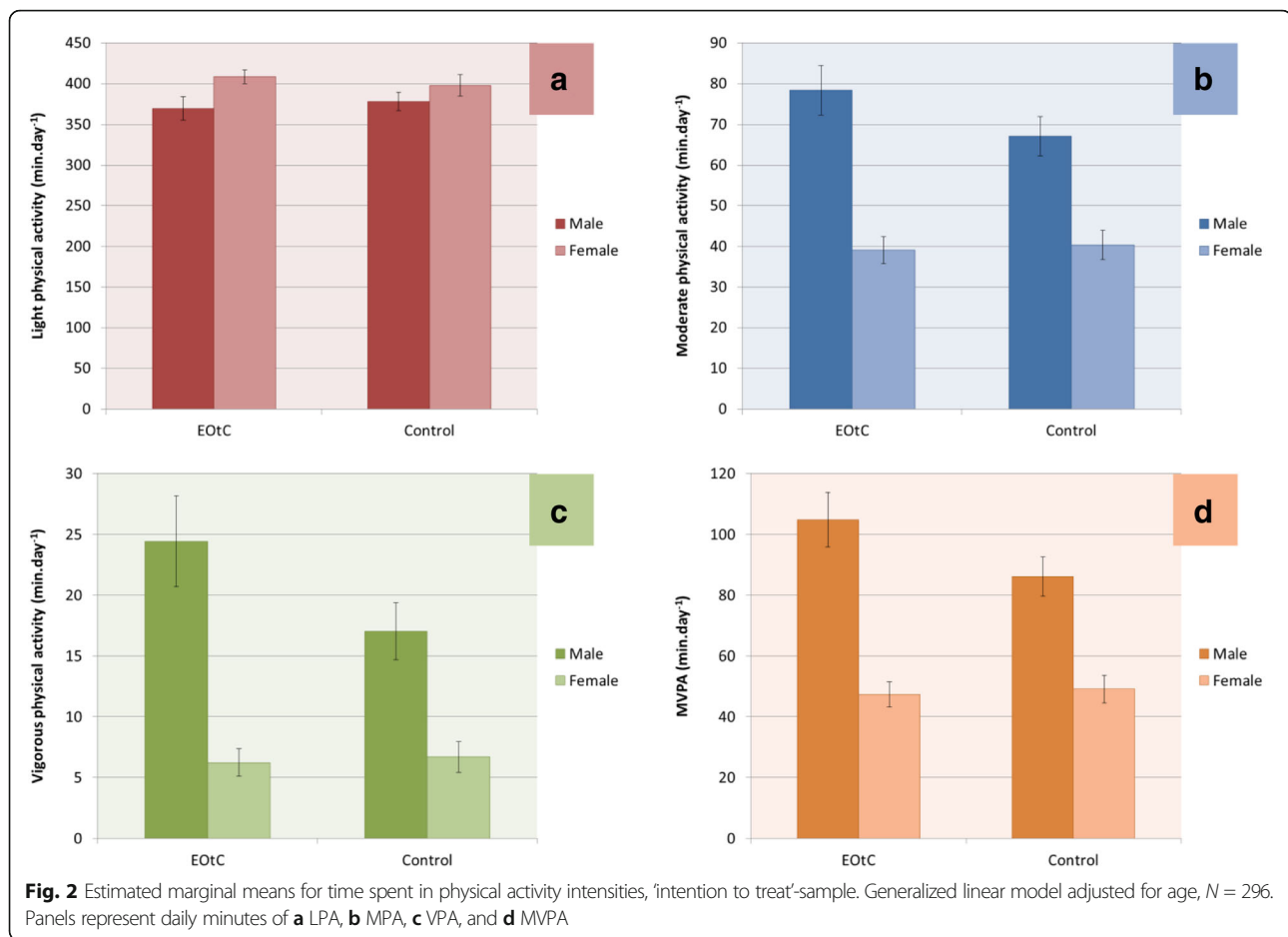
Class characteristics	Total population	EOTC group	Comparison group	Difference EOTC vs comparison	p, EOTC vs comparison
Number of schools	12	12	12	0	-
Number of classes	33	17	16	1	-
Weekly EOTC days	0.73 ± 0.83	1.06 ± 0.80	0.38 ± 0.70	0.68	0.017 (n = 33)^a
Weekly EOTC minutes	154 ± 171	239 ± 151	64 ± 142	175	0.002 (n = 33)^a
Classes with ≥150 min EOTC	15 of 33 (45%)	13 of 17 (76%)	2 of 16 (13%)	11	0.000 (n = 33)^b
Classes with ≥300 min EOTC	9 of 33 (27%)	7 of 17 (41%)	2 of 16 (13%)	5	0.065 (n = 33) ^b
Number of participants	663	346	317	29	-
Participants per class	20.1 ± 3.3	20.4 ± 3.2	19.8 ± 3.3	0.5	0.648 (n = 33) ^a
Participant characteristics	Total population, included participants	Total population, excluded participants	EOTC group, included participants	Comparison group, included participants	p, included EOTC vs included comparison
Proportion participants in group (%)	361 (54.4)	302 (45.6)	201 (58.1)	160 (50.5)	-
Proportion participants in EOTC (%)	201 of 361 (55.7)	147 of 302 (48.7)	-	-	-
Participants per class	10.9 ± 4.6	9.2 ± 3.7	11.8 ± 4.5	10.0 ± 4.4	-
Age, years	10.89 ± 1.03	11.12 ± 1.07	10.82 ± 1.05	10.95 ± 1.01	0.284 (n = 296) ^a
% girls	61.2	41.1	63.3	59.3	0.431 (n = 361) ^b
BMI, kg/m ²	17.3 ± 2.4	18.4 ± 3.1	17.2 ± 2.2	17.4 ± 2.6	0.392 (n = 360) ^a
BMI percentile*	44.2 ± 27.5	54.7 ± 28.5	43.7 ± 25.7	45.0 ± 29.5	0.683 (n = 296) ^a
% overweight/obese	9.8	20.1	7.9	11.4	0.315 (n = 296) ^b

Characteristics reported in mean ± standard deviations unless otherwise stated. p < 0.05 are bolded, n equals sample size included in statistical test and upper case letters refers to following statistical tests: ^aIndependent samples T-test, ^bPearson χ² cross tabulation test; *BMI percentile classification based on [27]

Table 4 Class and participant characteristics, Per Protocol-analysis

Class characteristics	Total population	EOTC group	Comparison group	Difference EOTC vs comparison	p, EOTC vs comparison
Number of schools	10	10	10	0	-
Number of classes	21	11	10	1	-
EOTC days	0.81 ± 0.79	1.36 ± 0.64	0.20 ± 0.40	1.16	0.000 (n = 21)^a
EOTC minutes	169 ± 159	306 ± 89	18 ± 36	288	0.000 (n = 21)^a
Classes with ≥150 min EOTC	11 of 21 (52%)	11 of 11 (100%)	0 of 10 (0%)	11	0.000 (n = 21)^b
Classes with ≥300 min EOTC	5 of 21 (24%)	5 of 11 (45%)	0 of 10 (0%)	5	0.015 (n = 21)^b
Number of participants	430	228	202	26	-
Participants per class	20.5 ± 3.1	20.7 ± 3.3	20.2 ± 2.9	0.5	0.714 (n = 21) ^a
Participant characteristics	Total population, included participants	Total population, excluded participants	EOTC group, included participants	Comparison group, included participants	p, included EOTC vs included comparison
Proportion participants in group (%)	258 (60.0)	172 (40.0)	143 (62.7)	115 (56.9)	-
Proportion participants in EOTC (%)	143 of 258 (55.4)	87 of 172 (50.6)	-	-	-
Participants per class	12.3 ± 4.3	8.2 ± 4.0	13.0 ± 4.4	11.5 ± 4.2	-
Age, years	10.62 ± 0.95	10.88 ± 1.17	10.55 ± 1.02	10.69 ± 0.88	0.298 (n = 222) ^a
% girls	61.6	43.6	65.0	57.4	0.152 (n = 258) ^b
BMI, kg/m ²	17.3 ± 2.5	18.1 ± 3.1	17.0 ± 2.2	17.5 ± 2.8	0.166 (n = 258) ^a
BMI percentile*	45.3 ± 27.5	53.6 ± 28.2	44.6 ± 25.8	46.1 ± 29.4	0.571 (n = 222) ^a
% overweight/obese	11.3	17.9	9.8	13.1	0.366 (n = 222) ^b

Characteristics reported in mean ± standard deviations unless otherwise stated. p < 0.05 are bolded, n equals sample size included in statistical test and upper case letters refers to following statistical tests: ^aIndependent samples T-test, ^bPearson χ² cross tabulation test; *BMI percentile classification based on [27]

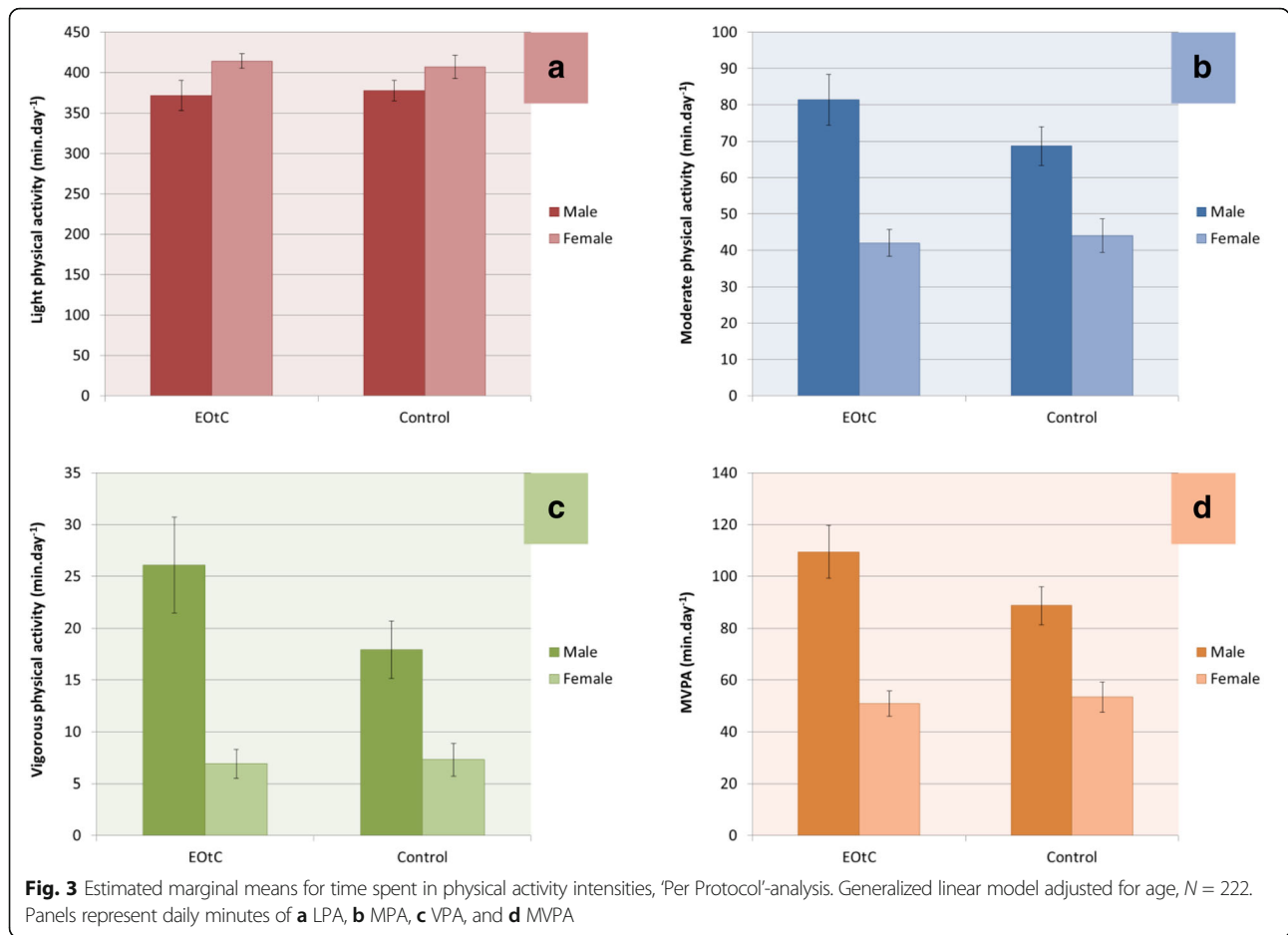


to randomize class pairs to the EOTC and comparison groups, 2) the group of participants who were excluded had slightly different characteristics compared to those included in the analyses, 3) we had a higher non-compliance rate for children in the comparison classes compared to EOTC classes, 4) the effect of EOTC on PA was evaluated based on weekly PA, and thereby included all activities throughout the measured week, 5) seasonality was not included, and 6) we did not collect baseline data.

We were unable to randomize classes because of the way EOTC is organized in Denmark. Teachers, and thereby classes, were included in the EOTC sample because they were willing to practise EOTC regularly throughout the school year. We chose the parallel class design to minimize the risk of selection bias related to differing background characteristics between participants in the EOTC and comparison groups. Due to the random assignment into classes in grade 0 in Danish public schools [23], participants in each class pair should be comparable in terms of demographics, local area, overall school resources, and anthropometric characteristics. The data in Tables 3 and 4 comparing the anthropometric characteristics

of participants included in the EOTC and comparison groups confirms the latter, as no statistical differences were found for age, sex and weight status between EOTC and comparison groups. However, 42% of participants in the EOTC group and 50% in the comparison group did not provide valid PA data. Also, participants excluded from analyses were more likely to be boys, older and overweight than the general study population. The retention rates observed may have caused the selection bias, as higher PA level, BMI percentile, and increases in age were negatively associated with lower back wear time of a tape-mounted accelerometer in our data collection [29]. This is likely a consequence of the strict inclusion criteria and should be considered in the interpretation of the results [43], especially when it comes to older and overweight children who are generally considered less physically active than younger and normal weight children [31, 32].

We monitored the extent of implementation of the intervention in both EOTC and comparison classes during the PA measurements period and included both an ITT and PP analysis. Although not all EOTC classes reached the required minimum of 300 min of EOTC they were asked to do, and some comparison classes participated in activities categorized as EOTC, the EOTC classes



averaged 175 more minutes of EOTc than comparison classes in the ITT analysis, and 288 more minutes in the PP analysis. The average duration of EOTc practiced during the week of PA measurements (239 min/week) was lower than the average reported across the school year for both EOTc classes (283 min/week) and control

classes (64 compared to 98 min). This suggests that differences in weekly minutes of EOTc practiced during the week of PA measurements and an average week throughout the school year were similar and therefore a good representation of EOTc activities occurring throughout the intervention school year. Differences in

Table 5 Estimated marginal means of daily minutes spent in physical activity intensities between subgroups

Group comparison	Sample	MVPA		VPA		MPA		LPA	
		Mean diff.	p	Mean diff.	p	Mean diff.	p	Mean diff.	p
EOTc vs comparison	ITT	8.4	0.010	3.5	0.004	5.0	0.036	1.1	0.855
	PP	9.2	0.016	3.9	0.009	5.3	0.052	0.6	0.936
Boys vs girls	ITT	47.3	<0.001	14.3	<0.001	33.0	<0.001	-29.2	<0.001
	PP	47.0	<0.001	14.9	<0.001	32.0	<0.001	-36.0	<0.001
EOTc vs comparison, boys only	ITT	18.7	0.006	7.4	0.006	11.3	0.029	-8.6	1.000
	PP	20.8	0.008	8.2	0.018	12.6	0.030	-5.9	1.000
EOTc vs comparison, girls only	ITT	-1.8	1.000	-0.5	1.000	-1.3	1.000	10.9	1.000
	PP	-2.5	1.000	-0.4	1.000	-2.1	1.000	7.1	1.000
Age*	ITT	-13.2	<0.001	-3.2	<0.001	-10.0	<0.001	-17.6	<0.001
	PP	-13.8	<0.001	-3.7	<0.001	-10.1	<0.001	-18.2	<0.001

*Mean difference per year increase in age. $p < 0.05$ are bolded. ITT intention to treat sample ($n = 296$) and PP per protocol sample ($n = 222$)

the amount of EOTC performed in the EOTC and comparison group in combination with no differences in characteristics between EOTC and comparison participants, suggest that the differences in PA between groups can be attributed to EOTC. However, more detailed analysis of the impact of EOTC on PA could be conducted by comparing different days and contexts, such as days with EOTC, normal school days, days with PE, and weekend days. In addition, the amount of EOTC practiced was self-reported, and there might have been reporting errors. To reduce these possible errors we combined self-reported data on EOTC practice from two sources: class diaries and teacher reporting's through the monitoring tool.

We successfully used tape-mounted monitors to obtain PA data with seven days of 24 h wear time and thereby removed or reduced the risk of shortcomings associated with current PA monitoring methodology in larger-scale studies [44]. E.g. we did not have problems due to intentional non-wear, changes to the accelerometer's position on the body and axis orientation, deciding and applying decision rules for detection of non-wear time, or the need to weight data due to differing number of days included. A study by Fairclough and colleagues [45] reported a need to include eight days for boys and 10 days for girls in order to achieve a 80% intra-participant reliability for whole day MVPA with a valid day set to include ≥ 10.1 h of wear time because of day-to-day variability. Data from our study showed a need to include 3.5 week days and 2.3 weekend days at 24 h wear time per day to achieve a 80% reliability for the PA construct "vector magnitude of three axes" [29]. Based on these findings, our strict seven days of 24 h measurements inclusion criterion indicates a high reliability of measured PA.

Weather conditions impact PA accumulation of children with autumn and winter being associated with lower PA levels compared to spring and summer [46]. The primarily outdoor nature of EOTC practice and our data collected only between November (late autumn) and April (early spring) may make our PA findings extra sensible to weather conditions. Also, we did not obtain baseline data and it is therefore unknown if children in the EOTC and comparison groups had different PA levels to begin with by chance, despite choosing a study design to achieve as similar groups as possible for comparison. Unfortunately, we were unable to apply a study design with baseline and follow-up measurement of PA for each class pair over the course of the entire school year.

Conclusions

Participants in the EOTC classes spent more daily time in MVPA than participants in their comparison classes; however, this difference was sex-specific, with boys in

the EOTC group accumulating 18.7 (ITT) and 20.8 (PP) minutes more MVPA daily than boys in the comparison group, while no difference in daily MVPA were found for girls in the two groups in either sample. This study was the first to investigate the effects of EOTC on a large sample and to implement seven full days of 24 h accelerometer measurements as inclusion criteria for high validity measurements of participants' PA. Implementing EOTC into schools' weekly practice is a cheap, supplementary way to increase time spent in VPA and MPA for boys through grades three to six.

Abbreviations

EOTC: Education outside the classroom; ITT: Intention to treat; LPA: Light physical activity; MPA: Moderate physical activity; MVPA: Moderate-to-vigorous physical activity; PA: Physical activity; PP: Per protocol; VPA: Vigorous physical activity

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Availability of data and materials

We did not obtain consent to data sharing outside of our research group from our respondents and their parents, so we cannot share our data publicly. A desensitized aggregated dataset is available upon request through the primary investigator of the study, Mikkel Bo Schneller, at mkbs@steno.dk.

Authors' contributions

MBS participated in the design of the study, physical activity data collection, performed statistical analysis, and drafted the manuscript. SD performed statistical analysis and helped to draft the manuscript. JS, GN, EM, and PB participated in the design of the study, data collection and helped to draft the manuscript. JS, GN and PB also participated in the data analysis. All authors read and approved the final manuscript.

Authors' information

Not applicable.

Competing interests

We declare no competing interests.

Consent for publication

Not applicable.

Ethics approval and consent to participate

By Danish law, only biomedical research projects or projects that involve risks for patients/participants can have their ethics reviewed by a Regional Ethics Board and receive a Trial Registration Number (<http://www.nvk.dk/english>). We have asked for and received a formal confirmation on 5 March 2014 (Protocol nr.: H-4-2014-FSP) from the Regional Committee on Health Research Ethics that this research project (the TEACHOUT study) was not regarded as biomedical research and no ethical approval were needed or possible to obtain.

All parents provided written informed consent, and the study was approved by the Danish Data Authorities (ref. number: 2014-54-0638).

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