

Preschool: Producers or Reducers of Inequality Regarding Physical Activity Levels in 4-6 year old Children

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Abstract

The study examines preschool children's physical activity level at preschool. Preschool children's activity level at preschool is also investigated related to activity level at leisure, gender, and mothers' education level, income, age and preschools staff's physical activity level. 244 children and 72 preschool staff supplied valid accelerometer data, and mothers' education level, income, and age were measured using a questionnaire. One-way ANOVA, linear regression and multilevel analysis, the linear mixed model (LMM), were utilized as statistical analyses. The results demonstrated that physical activity level during preschool is the main contributor to preschool children's physical activity level on weekdays. Furthermore, boys were more active than girls, and preschool children's physical activity level at both leisure and at preschool were not associated with mothers' age, education level, or income. However, a positive association was found between physical activity level at leisure and at preschool. Physical activity level was significantly different between preschools.

1. Introduction

Physical activity reduces the risk of illness, improves quality of life, and increases functional ability [1]. Moreover, physical activity strengthens muscles and the skeleton, develops skills, reduces anxiety and depression, bolsters self-confidence, and contributes to social interaction [2]. It is recommended that children engage in physical activity for a minimum of 60 minutes each day with moderate or high intensity (MVPA) [3]. Earlier research has shown, however, that not all children satisfy these health recommendations, and that the physical activity levels that are too low [4-9]. While Berglind et al. [10] found that 32.6 % of the Swedish four-year olds fulfilled the health recommendations of physical activity, Andersen et al. [11] show that almost 60 % of the children [average 3,7 years old], fulfilled these recommendations. Kalle et al. [12] showed that respectively 95.7 % and 87 % of the Norwegian six years old boys and girls fulfilled these recommendations. Several studies have also reported that boys are more active than girls [7, 9, 10, 13-18]. Studies have revealed that, in Norway and other countries, the activity level of children declines with increasing age [8, 12, 18-20]. Another study reported that, from the age of six, time spent being inactive

increases on average by 17 minutes for each year up to the age of 15 [1].

Almost all Norwegian children from three- to six-years-old, are in preschool most of their waking hours [21], and the preschool staff will have a major influence on children's physical activity levels. Consequently, it is asserted that the preschool can contribute to influencing children's health in the short and long term, and also to levelling social differences, which constitutes an important principle underlying public-health work [1]. A study showed that children in Norwegian preschools spent approximately nearly four hours outdoors [22]. According to Herrington and Brussoni [23] outdoor activity, particularly in natural play spaces, boosts children's physical activity. Finn et al. [14] found that more than 50% of the average daily activity occurred during children's preschool hours. This demonstrates that preschools may be an especially important arena for decreasing social differences due to physical activity level among children. According to both Rossem et al. [24], and Borraccino et al. [25], lifestyle behaviour will follow the same trend from preschool age up to adulthood. Several researchers highlight the importance of preschool staff being involved and making efforts to promote children's physical activity, and furthermore, that policy and practice in preschool greatly impact the total physical activity level of children [7, 26-28].

One of society's major challenges is to maintain the activity level of children and to prevent the development of differences in activity levels based on socio-economic variables [1]. Socio-economic variables appear to exert a major impact on the activity levels of both youths and adults [29, 30]. Cotrell et al. [31] found that children [aged 5 to 15] from families with lower incomes, received more approbation for being physically active outdoors, and their parents more often participated in the activity with them. Kimbro et al. [32] determined that preschool children from families with lower socio-economic status had more unstructured time, which contributed to more physical activity than it did for children from families with higher socio-economic status. On the other hand, Pate et al. [7] reported little difference in activity level (MVPA) between children aged three to five, considered in relation to parental education. This is supported by

Telford et al. [33], which did not find a link between the physical activity of five- to six-year-olds in their free time, and socio-economic status. The

previous discussion points to the importance of preschools in relation to preschool children's activity level and reducing inequality in physical activity level among preschool children. However, there is a lack of research that has examined children's activity level in preschool with objective measures, such as accelerometers, and controlling for variables, such as gender, and mothers' education level, income, and age. The main aim of the current study was to elucidate whether the preschools succeeded to reduce inequality in physical activity level among preschool children [4-6 years-old] at leisure, by providing all preschool children with the same activity level at preschool.

The purpose of the study is operationalized into the following four research questions:

1. What is the contribution of preschool children's MVPA at preschool in order to achieve the international health recommendation of 60 MVPA daily?
2. Are there any differences between MVPA at preschool in different preschools and do the preschool staff's and the childrens MVPA correspond?
3. To what extent is preschool children's MVPA at preschool related to gender, their mothers' education level, income and age?
4. Do the preschools succeed to reduce inequality according to the physical activity in MVPA among preschool children that occurs during leisure time?

2. Material and Methods

The present study was conducted in collaboration with a larger Ph.D research project (unpublished) that used accelerometers, questionnaires, observations and interviews. However, as the aim of the present study did not comprise all aspects of the data collection, only accelerometer data and questionnaire data were included. To answer the above research questions, accelerometers were used among preschool children and preschool staff, and questionnaires among the children's parents. Accelerometers were chosen because they can detect intensity, frequency, and duration of children's physical activity [12, 34-36]. Moreover, the use of accelerometers make it possible to compare data with a national population study of physical activity level among pre-schoolers [12]. Questionnaires are the most common tool for measuring education level, income, and age.

2.1. Subjects

Of 122 preschools in four councils in Nord-Troendelag county, 13 preschools were randomly selected to participate in the study, independently of size and type of preschool. The preschools were located in the same socioeconomic area. A condition

for participating in the study was that children were full-time in preschool. The 13 preschools included 364 full-time children at the age of 4-6 years. 244 children and 72 preschool staff who worked mainly with the children aged 4-6 had valid accelerometer data. The number of 4-6 year-old children in full-time preschool varied widely [see Table 1].

2.2 Procedures

Accelerometer data and questionnaire data were collected during May and June, 2017. Prior to signing the written consent form and the data collection, preschool teachers and parents received written and oral information about the procedures and ethical standards for testing related to sports science. Actigraph GT1M accelerometers [ActiGraph, Fort Walton Beach, FL, U.S.A.] were utilized to objectively measure preschool teachers and 4-6 year-olds' physical activity over seven consecutive days, which is recommended by several researchers [12,17, 37, 38]. Participants were instructed that the accelerometer had to be placed on the right hip according to Kolle et al. [12], and worn every day except for during sleep, showering, or other activities involving water. During the data collection, the participants [childrens mother and father and preschool staff] received an SMS each morning, reminding them to have their child wear the accelerometer. Raw data output produced from the accelerometers are expressed as counts per minute [CPM], which refers to all acceleration to which the accelerometer has been exposed, divided by the number of minutes the accelerometer has been used [12]. According to the test protocol of Kolle et al. [12], counts are summed during 10 second intervals for the children and 60 second intervals for the preschool staff in order to capture as precise data as possible. Furthermore, the accelerometer data were classified as sedentary, light, moderate and vigorous physical activity, according to the divisions used in a national population study of physical activity level among pre-schoolers [12]. The children's moderate and vigorous physical activity [MVPA] level during the time in preschool is used as the dependent variable in this study. For initializing the accelerometers, to download accelerometer data, and to validate and create accelerometer data [MVPA], Actilife v6.13.3 [ActiGraph, LLC, Pensacola, FL, U.S.A.] was used. Accelerometers were set to start recording at 6:00 am the day after they were distributed and put on, in an effort to counteract the Hawthorne Effect [39]. According to the test protocol, at least 480 minutes of daily recorded activity were required to obtain a valid day, and 20 minutes or more with consecutive zero counts were interpreted as non-wear time and removed [12]. Furthermore, the preschool children were required to have at least two valid days to be included in the

study. Data between 12:00 am - 5:59 am were excluded due to instructions concerning no accelerometer-wearing during sleep. Finally, the MVPA among preschool children at preschool [school day] was categorized as 8:00 am - 3:29 pm, and MVPA among preschool children at leisure on weekdays was categorized as 6:00 am - 7:59 am, and 3:30 pm - 11:59 pm. Weekend was categorized as 6:00 am - 11:59 am Saturday and Sunday. These operationalisations were made according to feedback from several of the preschool staff and parents of the preschool children, who identified these times as time spent in preschool and leisure, respectively. The questionnaire was designed on the basis of already validated and reliability-tested questions from studies of Hansen et al. [40] and HUNT3 [41]. The questionnaire was pre-tested by 10 parents of 4-6 year-old pre-schoolers in a preschool that was not selected for the study. To visualise the importance of preschool according to preschool children's MVPA level at preschool, MVPA level among preschool children at preschool was categorized from 1 to 13, with the preschool with the highest MVPA level first [1] and by decreasing activity level until the preschool with the lowest activity level [13]. The distribution of children in the preschools is presented in Table 1.

Table 1. Descriptive data of the 244 children [4-6 years-old] by increasing MVPA at preschool

Preschool number	Number of children
1	10
2	5
3	34
4	25
5	14
6	6
7	27
8	29
9	16
10	28
11	16
12	24
13	10

2.3. Statistics

The distribution of the dependent variable [MVPA at preschool] seemed to follow a normality curve. However, the Kolmogorov-Smirnov test and the Levene's test [42] showed that the assumption of normality and similar variances was not met [$p < .05$]. According to Vincent and Weir [43], however, the F test [ANOVA] produces valid results even when the sample is not normally distributed or with variability in the sample. This assertion is also

supported by Lumley et al. [44], especially related to the high numbers of subjects in the present study. Lumley et al. [44] also make this point regarding the use of linear regression. A one-way ANOVA was employed to determine if there were any differences in preschool children's MVPA at preschool between the preschools, with a post hoc test using Bonferroni corrections. Paired sample t-tests were used to examine differences between children's MVPA level at leisure and preschool. To find to what extent preschool children's MVPA at preschool was related to MVPA at leisure and their mothers' education level, income, and age, linear regression was utilized. However, since the assumptions of continuous variables were not met according to mothers' education level and income (see Table 3), these variables were dichotomized into categorical variables [low education: primary school and high school, high education: university education, and low income: < 500000 nkr, and high income: > 500000 nkr]. The level for significance was set at $p < .05$. Since children are nested in different preschools, data were characterized as hierarchical, as a child's activity level might be affected by other children's activity levels in the same specific preschool. Consequently, a multilevel analysis (linear mixed model (LMM) analysis) was used to examine associations between children's activity levels and preschool staff's activity levels, as it can handle data dependency that occurs in such cases. Moreover, a multilevel analysis has been considered as a suitable method to capture social contexts with several levels [45]. Statistical analysis was performed with SPSS, version 24.0 [IBM, Armonk, NY, U.S.A.].

3. Results

The results in Table 2 reveal that 84% of the children reached the international health recommendations of physical activity of 60 MVPA daily during their weekdays and weekends, taking their total MVPA into account. In addition, only 3.7% of the children achieved the international health recommendations of physical activity of 60 MVPA daily on weekdays during their leisure, while 39.8% of the children reached the international health recommendations of physical activity of 60 MVPA daily on weekdays during their time in preschool. Further calculations showed that the time children spent at preschool contributed to 48.8% of the children's total MVPA.

Table 2. Descriptive characteristics of children [aged 4-6 years-old]: Minutes in MVPA and fulfilling health recommendations

	Boys [SD]	Girls [SD]	Total [SD]
Sample size [n]	125	119	244
MVPA preschool hours [minutes]	61.7 ±18.3	55.1 ±17.3	58.4 ±18.1
MVPA leisure time weekdays [minutes]	33.6 ± 12.6	30.8 ± 12.8	32.3 ±12.8
MVPA weekend [minutes]	75.6 ± 31.5	69.3 ± 27.9	72.5 ±29.9
Health recommendations Met [%]	89.6	78.2	84
Met during preschool hours weekdays [%]	45.6	33.6	39.8
Met outside preschool hours weekdays [%]	5.6	1.7	3.7
Met during weekends [%]	0	0	0
Not met [%]	10.4	21.8	16

A one-way ANOVA revealed that the pre-schoolers' MVPA level at preschool is significantly different between the 13 preschools [F12 = 5.1, p<.001]. In Figure 1, the activity level of children at preschool is organized by increasing [mean] minutes of MVPA in the 13 preschools.

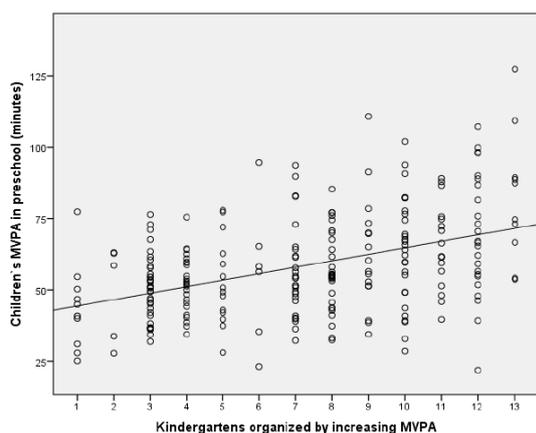


Figure 1. Scatter plot with preschool children's MVPA at the 13 preschools organized by increasing MVPA level on the X axis, and preschool children's MVPA at preschool on the Y axis

Post hoc tests with Bonferroni corrections showed that preschools 12 and 13 had significantly higher activity levels than preschools 1-3 and 1-4, respectively [p < .05]. The intraclass correlation revealed that 19.5% of the total variance in MVPA at preschool is explained by the preschool. To elucidate how the preschool succeeded to reduce differences in activity level that could have arisen at leisure time, related to their mothers' education level, income, and age [controlled for the effect of gender], was a main aim of the study. Table 3 present descriptive data concerning how these independent variables are related to preschool children's MVPA, both at preschool and leisure.

Table 3. Characteristics of the children's MVPA level at leisure and preschool on weekdays, according to the independent variables: Mothers' education level, income, and age

Mothers' education level	Leisure time Mean [SD]	Preschool Mean [SD]	N
Less than 7 years primary school	21.2	71.4	2
7-10 years primary school	33.5	48.7*	8
High school, vocational subjects	33.2	55.7*	46
High school, specialization in general studies	33.5	57.3*	22
1-3 years university/college	28.8	53.9*	53
4 years or more at university	28	55.5*	67
Mothers' income			
Up to 299 000 Nkr	32.2	54.6*	39
300 000 – 499 000 Nkr	32	57.7*	103
500 000 – 699 000 Nkr	25.8	54.4*	38
700 000 – 899 000 Nkr	19.6	48.9	3
900 000 – 999 000 Nkr	24.2	63.3	4
More than 1000 000 Nkr	34.2	56.4	5
Mothers' age			
20-24 years-old	34.2	57.7*	6
25-29 years-old	33	55.1*	41
30-34 years-old	31.8	59.8*	64
35-39 years-old	31.4	61.7*	49
40 years or older	26.2	57.9*	25

*Significant higher MVPA at preschool time compared to leisure time, p<0.05

* Nkr = Norwegian kroner

The results in Table 3 show that the children's activity level is significantly higher at preschool time than at leisure time on weekdays in almost all groups. The data indicate that neither mothers' education level, income or age seem to have linear associations with MVPA at preschool or at leisure. The results of the linear regression analyses that are presented in Table 4 identify which of the variables predict activity level at preschool.

Table 4. Factors associated with preschool children's MVPA level at preschool

Variables	b [st.e], p
Increasing MVPA preschool	-2.33 [.34], p<.001
Mothers' education level [low/high]	-2.61 [2.59], p=.314
Mothers' income [low/high]	-.23 [2.92], p=.937
Mothers' age	.14 [.27], p=.612
MVPA leisure	.59 [1.00], p<.001
Children's gender	-5.08 [2.32], p<.05
Constant/R ²	58.82/.36

In table 4 the 13 preschool with increasing MVPA was included in the linear regression. The results in

Table 4 reveal that neither mothers' education level, income, or age predicted MVPA at preschool [$p > .05$]. However, Table 4 shows that children's MVPA during leisure and children's gender predicted MVPA in preschool.

Figure 2 shows how the preschool children's MVPA at leisure is associated with their MVPA at preschool, and how the preschool succeeded to create high levels of MVPA at preschool for preschool children with low physical activity levels at leisure.

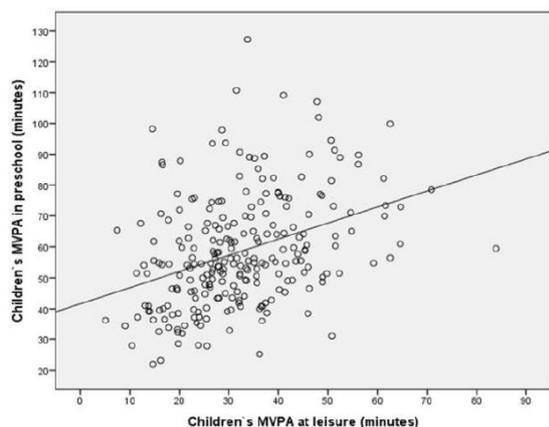


Figure 2. Scatter plot with preschool children's MVPA at leisure on weekdays on the X axis, and the same preschool children's MVPA at preschool on weekdays on the Y axis

Figure 3 shows the MVPA level among girls and boys at preschool. It is shown that MVPA level among boys is higher than among girls.

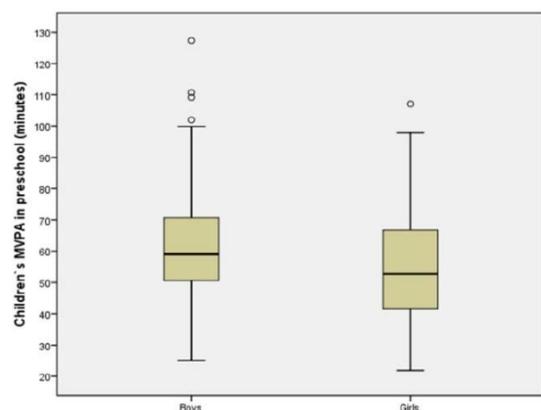


Figure 3. Box plot with boys and girls on the X axis, and their MVPA at preschool on the Y axis.

The LMM-analysis shows that a significant association exists between preschool staff's average activity levels during preschool hours and the children's predicted MVPA during preschool hours in each preschool [$t=2,57$; $p=0,013$; $f^2 = 0.013$].

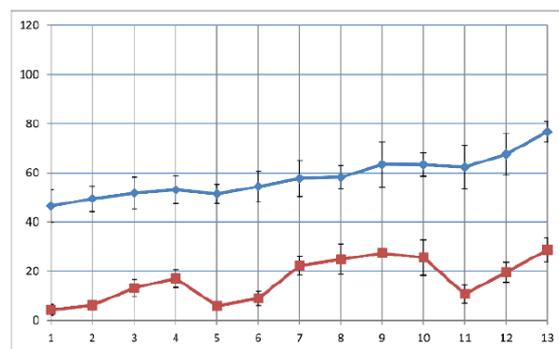


Figure 4. Preschool staff's aggregated data during preschool hours with children's predicted MVPA during preschool hours in each preschool

Figure 4 shows how the average in both the staffs and children's MVPA in each specific preschool correspond.

4. Discussion

The first main finding was that 84% of the children satisfied the international health recommendations for physical activity of 60 minutes of MVPA daily during weekdays and weekends, taking their total MVPA into account. Furthermore, the results showed that MVPA during preschool was the main contributor to preschool children's total MVPA during weekdays, by contributing approximately twice as much to MVPA level during weekdays than MVPA during leisure time, a significant difference [Table 3]. During the entire week, preschool contributed to approximately half of the children's MVPA. This is in accordance with Finn et al. [14], who identified day care as the strongest determinant for physical activity. The activity level of 4-6 years old children in preschool time in our study [mean MVPA = 58.4] is somehow in accordance with other studies. Cauwenberghe et al. [46] found that the average time spent on MVPA was 44.2 min. on days with organized activity, and 34.1 min. without organized activity in preschool. Kain et al. [47] also highlights that organized activity increase childrens physical activity level. Pate et al. [7] reported that children aged three to five were active in MVPA for seven minutes an hour during their time in day care. The second main finding was that MVPA levels were significantly different between the 13 preschools. Two of them had significantly higher activity levels during preschool time than the three preschools with the lowest activity levels. This indicate that preschool staff might have a crucial impact on children's activity levels if they provide a supportive environment in which physical activity is prompted regularly. This might contribute to explain the findings in figure 4, as preschool staff from preschools with high activity

levels might have inspired the children to be more active, or preschool staff chose to be physically active with the children. Vanderloo et al. [2014] highlighted the fact that lack of stimulation or inactive preschool staff as role models will demotivate children's physical activity. Our findings, that the differences in levels of activity are created in day care, and that no differences exist between children's MVPA out of day care, are supported by both O'Neill et al. [48] and Grøntved et al. [49]. The fact that the differences in children's activity levels are created in preschools led by "professionals", is a surprising finding and problematic from a social perspective. Our findings point to the importance of striving for a culture in which the staff adapt to common values and nurture a collaborative culture for increasing physical activity [50]. Our study may suggest that the three preschools that exhibit the lowest activity levels may need to emphasize work with physical activity to a greater extent than they currently do. Despite the culture of spending lot of time outdoors in Norwegian preschools, which boosts children's physical activity level [23], some preschools do not manage to give all children sufficient physical activity in preschool. Bjørgen and Svendsen [26] identified the critical importance of preschool staff being involved and making efforts to promote children's physical activity, and highlights the importance of enthusiastic adults that initiate, lead, and are excited about the activities as the key to stimulation of motivation and enjoyment.

The third main finding is that preschool children's MVPA level during preschool time was not associated with mothers' age, education level, or income. However, Table 3 show that children's MVPA level at leisure time was not related to their mothers' education level, income, or age. This finding may seem surprising in light of the extant literature. Borraccino et al. [25] found that the physical activity levels of children, increased with parents' socio-economic status and Cleland et al. [51] found that, for boys, the mother was important as a role model for physical activity, and the father's reinforcement [praise for participation in physical activity] and direct support [bringing the child to activities, payment for participation and equipment] constituted the factors that influenced physical activity most positively. For the girls, it was the mother's and siblings active participation in physical activity, that was most critical in relation to physical activity in MVPA. We will argue that our findings indicate that children are naturally active, and that the sociological processes leading to differences in activity level that have been found among adolescents, have not yet been elucidated. The children's sports provisions in Norway do not permit children younger than six to compete in sports [52], and participation in organised sport do not start before children start school. This may contribute to

the fact that the focus on the amount and quality of physical activity begins when the children start school. The fact that children's level of physical activity is not associated with socio-economic status, may also be because children have a natural need for movement. It is known that children require a shorter time for restitution regarding heart rate, ventilation, and CO₂ than adolescents, and children's tempo in physical activity may be explained according to restitution time [53]. We would point out that our study is based on the socio-economic status of the children's mother. Furthermore, our results revealed that boys were more active than girls, resulting in more boys than girls meeting the health recommendations for physical activity. This is visualized in figure 3. Thus, our findings support several studies which have found that boys are more active than girls [7, 9, 10, 14-17]. However, it is worth noting that Pate et al. [7] asserted that boys being more active than girls may be linked to how the staff behave as role models for boys and girls in day care, as well as to what the staff think about the gender roles of boys and girls. Pate et al. [7] argues that the differences between girls and boys are due to socio-cultural factors. Typically, in physical activity, boys play in larger groups, with greater risk, and with more bodily contact. Pate et al. [7] also proposed that girls receive less encouragement to participate physically in the course of the day in day care. Penpraze et al. [17] also argued that the differences between girls and boys are not biological, citing that girls are more active during weekends than boys. Our does not find that girls are more active than boys during weekends [Table 2]. The fourth main finding was that a positive association existed between MVPA during leisure time and MVPA at preschool, in which MVPA at preschool increases when MVPA during leisure increases [Table 4]. This is visualized in figure 2. In other words, the preschools do not reduce inequality according to the physical activity level among preschool children that occurs during leisure time. In general, day care increases such differences and contributes to creating even larger differences between low-active and high-active children. O'Neill et al. [48] found that children who did not meet the PA guidelines in school, did not "catch up" with children who met the guidelines. This underlines the importance of increasing the level of physical activity for all children in day care. Preschools are obliged to promote equal opportunities and equality, to base their activities on principles of equal rights and non-discrimination, and to facilitate the children to interact in, and create, an equal society [54]. The staff must reflect on their own attitudes to be able to optimally present and promote equality and equal rights according to physical activity level [54]. Children learn best through support from others, and the preschool staff should provide opportunities to

enrich the activity by extending children's thinking [55].

The conclusion of the study is that preschools increase the differences in children's total MVPA. The study also indicates that children's physical activity level depends on the preschool staff's physical activity level in preschool. This demonstrates the importance of physically active role models to promote increased physical activity level in all children in preschool. This study also demonstrates the importance of striving for a culture in which the staff adapt to common values and nurture a collaborative culture for increasing physical activity.

5. References

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