

Levels, factors and interventions of preschool children physical activity: a systematic review

Níveis, fatores e intervenções da atividade física em idade pré-escolar: uma revisão sistemática

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Abstract *The goal of this study was to complete a systematic review of research on the occurrence the levels of physical activity (PA), forms of intervention and factors associated with this practice among preschool children. Studies published in the period between 2006 and 2016 were investigated, using the PubMed and SPORTDiscus databases. The search terms identified 177 articles, of which 41 met the inclusion criteria. Goals, methodologies and results were analysed. The studies used various cut-off points to establish the desired level of PA, along with different types of interventions. Overall, the problem of low level of PA among preschool children appears to be increasing. Involvement and participation of parents and teachers, guidance from booklets and other information sources, parent instruction and availability of extracurricular activities were considered positive factors that tended to increase children's PA levels, whereas parental obesity was a negative factor. New studies to define sedentary behaviour in preschool children are required to clarify the nature of this problem, along with the establishment of prevention programmes with ecological design aimed at schools, families and other sectors of society.*

Key words *Review, Child Preschool, Physical Activity, Sedentary lifestyle*

Resumo *O objetivo deste estudo foi realizar uma revisão sistemática sobre níveis de atividade física (AF), formas de intervenção e fatores associados a essa prática em pré-escolares. Foram considerados os estudos publicados na última década, as bases de dados consultadas foram: PubMed e SPORTDiscus. As palavras chave identificaram 177 artigos, dos quais 41 preencheram os critérios de inclusão. Foram analisados os objetivos, as metodologias e os resultados de cada artigo selecionado. As pesquisas utilizaram diferentes frequências e tipos de intervenções em atividade física. Em geral, o problema do baixo nível de AF em pré-escolares tem aumentado. O envolvimento e a participação dos pais e professores, cartilhas de orientação, outras fontes de informação, instrução aos pais e professores e disponibilidade de atividades extracurriculares foram considerados como fatores positivos que provocam a elevação dos níveis de AF nas crianças, por outro lado, a obesidade dos pais foi um fator negativo. São necessários novos estudos para definir o comportamento sedentário de pré-escolares, esclarecer a natureza desse problema juntamente com o estabelecimento de programas de prevenção, baseados em metodologias ecológicas, direcionados as escolas, famílias e outros setores da sociedade.*

Palavras-chave *Revisão, Pré-escolar, Atividade Física, Estilo de vida sedentário*

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Introduction

According to Kohl et al.¹ the sedentary lifestyle is the world's fourth leading cause of death. It is manifested at all ages and has been linked with numerous diseases, such as obesity, hypertension and heart disease. It also has impaired aspects of human development and welfare, accentuating inadequate health and nutrition.

Until the end of the twentieth century, sedentary lifestyle and obesity were studied as public health problems in adults, especially the elderly and little was known about their incidence in children under age five². Studies concerning preschool children began to emerge in the early 21st century, demonstrating the negative consequences of obesity, sedentary behaviour, low physical activity levels and motor deficits. In addition, there is evidence to suggest engaging in physical activity in the early years of life, as behavioral changes in the lifestyle healthy are more likely in children than in youth and adults^{3,4}.

It is predicted that by the year 2020, nearly 60 million preschool children will be overweight or obese; currently there are 43 million such children⁵. The probability of an overweight young child becoming obese by adolescence is four times greater than that among children with normal weight⁶.

Meanwhile, studies have demonstrated the importance of PA for children, showing its benefits for intellectual and cognitive development, psychosocial development and the promotion and acquisition of fundamental motor skills^{7,8}.

Researches on the level of physical activity aimed at children up to five years of age are still inconclusive², recommendations on the level of physical activity, methods and intervention strategies need to be better investigated.

Currently, the lack of PA and the tendency towards sedentary behaviour among preschool children have attracted considerable attention from researchers and from society in general, but the factors leading to this condition have still not been clearly elucidated. Therefore, the goal of this study was to complete a systematic review of research on the occurrence the levels of physical activity (PA), forms of intervention and factors associated with this practice among preschool children.

Methods

As a systematic review, this study sought to complete a systematic review the current state of research knowledge related to PA among preschoolers. The PRISMA checklist⁹ was applied. The articles were selected between May and July 2016 through the CAPES periodic portal, linked to a university, from the databases PubMed and SPORTDiscus using the following descriptors from DECS/MeSH (Medical Subject Headings): preschool children, physical activity, sedentary behaviour, environment, parents and preschool teachers.

To be included in this systematic review, papers must have been published between 2006 and 2016 (period chosen because of the exponential increase in sedentary behaviour) in journals with a peer review system. Three levels of stratification were carried out. First level stratification, all articles with one of the descriptors were selected. Second level stratification the abstracts were subjected to a screening in relation to the research problem. And the stratification of third levels the articles in which the main subject of the study, did not refer to the theme of physical activity in preschool children (levels, factors and interventions), articles that were not obtained due to lack of access to the full text and articles that age group did not agree with the research were excluded along with all duplicated articles.

The stratification identified 177 articles in the two databases used, but most of them did not relate to the theme of this study. Their removal left 41 studies (24 original articles presented in the tables and 12 review articles used to substantiate the analyses and five international recommendations of physical activity for preschool children to compare with the studies) that met all the criteria, and these became the sample used in the present study. Figure 1 display the flow chart of the stratification the articles selected.

After the inclusion and selection of the articles, were analysed the primary and secondary objectives, methods, results, in which it provided a reflexive analysis (by comparison among the findings); answers to the questions addressed and suggestions for future research.

This analysis revealed three units for study: (a) PA levels for preschool children and sedentary behavior, (b) implementation of PA programmes for preschool children and (c) factors associated with the practice of PA among preschool children, factors associated with teachers, factors associated with the family context and factors associated with the school context.

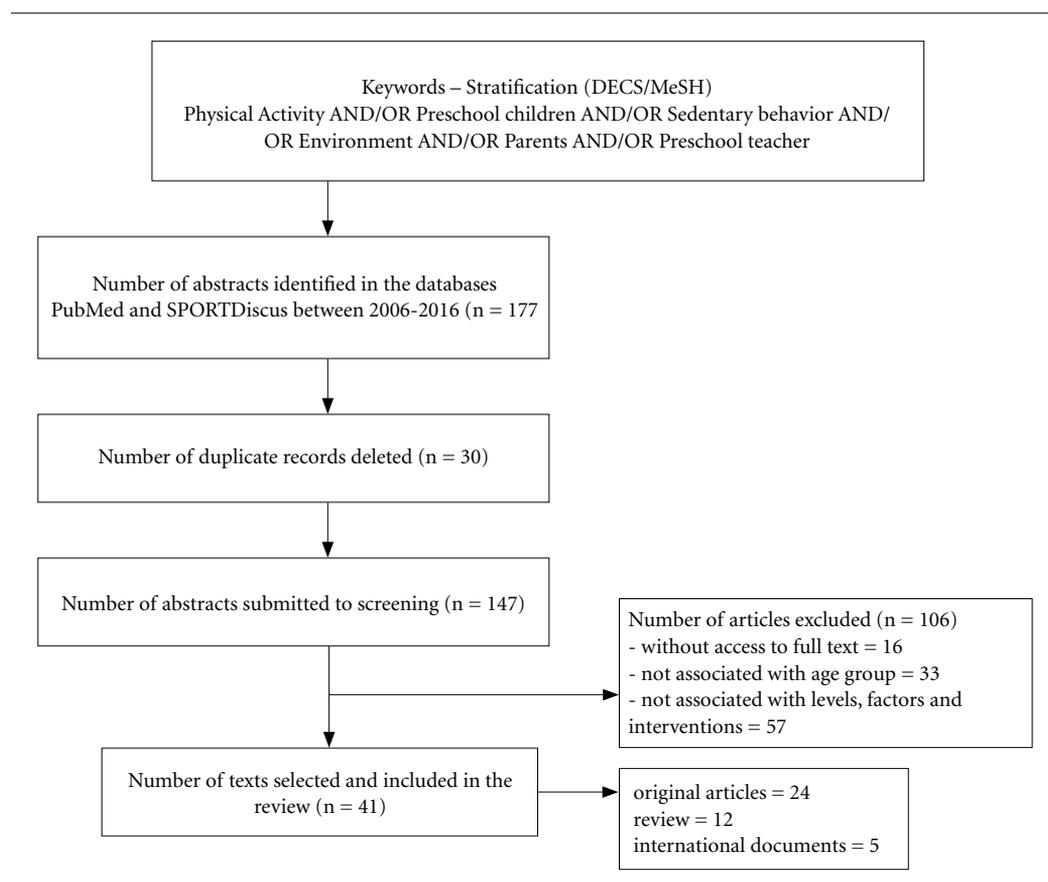


Figure 1. Flowchart of stratification, selection and inclusion of articles.

To clarify the cut-off points that can be used to establish the desired level for such activities among the different studies, five official recommendations to guide PA for children under five years old were examined.

Literature Review

Physical Activity Levels for Preschool Children

Seven cross-sectional studies from between 2006 and 2016 were found that analysed the PA levels of preschool children. They examined Portuguese¹⁰, Danish¹¹, Canadian¹², Brazilian^{13,14} and American children^{15,16}. The subjects' age group from two to six years; the smallest group had 65 preschool children and the largest had 631.

Of the 7 studies, five used accelerometers Actigraph GT3X or GTM1: two only accel-

ometer^{10,16}; one accelerometer and observation in the institutional context¹¹; one accelerometer and routine observation¹⁵; and one accelerometer and questionnaire in school¹⁴, as the literature attributed greater precision and objectivity, and the others two studies used questionnaire: one validated questionnaire and adapted to Brazil¹³ and one semi qualitative questionnaire to parents¹².

Meantime this instrument (accelerometers) does not provide additional information of environment frequented by children¹⁷ and also need to unify measures of the level of PA performed by accelerometer¹⁸, because dependent on the interpretation of accelerometry data.

Different cut-off points to indicate the desired level of PA practice were used, as various countries have different official recommendations. The first guide containing PA practice recommendations for preschool children was proposed in the United States, by the National Association for Sport and Physical Education¹⁹.

It recommended at least 60 minutes of moderate and vigorous PA daily (at least 3 day/week). The second edition of this guide suggested that preschool children (age three to five) should engage in at least 120 minutes of total PA per day, including 60 minutes of structured activities (planned with professional guidance) and another 60 minutes of unstructured activities²⁰.

Other recommendations published in Australia²¹, the United Kingdom²² and Canada²³ called for at least 180 minutes of daily PA for preschool children. Thus, there is no consensus on this issue. Brazil and Denmark did not indicate having any guidelines or official recommendations regarding PA for preschool children.

Using the original NASPE guidelines (which called for a minimum of 60 minutes of daily exercise), four studies found low levels of PA in 25% to 87% of the total participants, and sedentary behaviour in 50% to 83% of them. For instance, Tucker²⁴ investigated 39 studies from seven countries (United States, Scotland, Finland, Australia, Chile, Estonia and Belgium) and determined that across all these studies, 46% of preschool children showed low levels of PA, considering the recommendation of 60 minutes daily.

Three studies adopted the Canadian recommendations (180 minutes of daily PA) and found low levels of activity in 62% to 90% of all participants, while the incidence of sedentary behaviour varied from 64% to 90%. Chart 1 illustrates the findings of these studies.

Since three countries prescribe a daily minimum of 180 minutes of PA for preschool children (the Australia²¹, United Kingdom²² and Canada²³), whereas the American recommendations have had cut-off points of 60 or 120 min/day (NASPE^{19,20}), the choice between classification systems affects the number of children characterised as having insufficient PA. This inconsistency concerning the desirable minimum amount of PA was highlighted by Timmons et al.²⁵ and hinders comparisons among PA levels found in the studies. Moreover, all four countries' (United States, England, Canada and Australian) recommendation of PA was derived from studies of adult populations and was adjusted for children under age five based on empirical observations. Although these actions are justified in view of the evidence of a relationship between lack of PA and increased health risks in early childhood, a more focused review is still desirable to establish consistent guidelines, identify suitable health goals and assess worldwide levels of inactivity among preschool children, as well as to clarify observations across different countries.

Despite this analytical difficulty, the results of the present review indicate that sedentary behaviour is increasing and that PA levels of preschoolers are often lower than those prescribed even by the US recommendations. Considering the NASPE criterion of 60 min/day of PA, the average percentage of children with low levels of PA across two review studies^{24,26} varied in 34% a 94% and in this study it is 86% (sum of all mean of each study). This confirms that the risk of sedentary behaviour has increased in the period between 2006 and 2016. Of course, if one uses the stronger NASPE criterion of 120 min/day or the other three countries' recommendation of 180 min/day, the percentage of insufficiently active children is even higher.

This situation is dangerous from a public health perspective because low levels of PA may enhance the risk of developing diseases associated with sedentary behaviour, such as obesity and cardiovascular diseases⁵, as well as other developmental risks^{8,25}.

Timmons et al.²⁵ and Ginsburg²⁷ have disagreed with the idea of defining an exact period of time for which all preschool children should perform PA, arguing that it should be a natural and meaningful action for all children, everywhere and at all times^{25,27}. However, systematic observations of the daily life activities of preschool children have shown that children often do not receive adequate opportunities to experience PA as a meaningful and natural action²⁸.

Therefore, it is important to establish reliable and efficient guidance that considers the various characteristics of preschoolers and analyses other factors that may be associated with low PA levels in preschool children. Additionally, it is important to review how PA programmes have been implemented for such children during the period between 2006 and 2016.

Implementation of Physical Activity Programmes for Preschool Children in the Period between 2006-2016

Among the studies of PA programmes in actual practice in the period between 2006 and 2016, this review focused on ones that examined children from the US^{29,30}, Germany^{31,32}, England³³, Belgium³⁴ and Canada³⁵. The age of children studied ranged from three to six years old and the sample size of children varied from 50 to 826 participants. The period of the intervention programmes ranged between six weeks and two years.

Chart 1. Transversal studies about physical activity levels in preschool children in the period between 2006-2016*.

Authors	Method	Results
Vale et al. 2010 ¹⁰	Sample Cross-sectional: 245 Portuguese Age group: 3-6 years American Recommendation Instrument: Accelerometer Actigraph GTM1 Frequency: 120 min TPA and 60 min MVPA/day	Weekdays 25% and 6.5%, weekends 40% and 22.4% with low levels of TPA and MVPA. Sedentary behavior: 83%.
Barros et al. 2012 ¹³	Cross-sectional: 65 Brazilian Age group: 3-6 years American recommendation Instrument: Questionnaire to parents Frequency: at least 60 min MVPA	65% of children with low levels of MVPA.
Olesen et al. 2013 ¹¹	Sample Cross-sectional: 426 Danish Age group: 5-6 years Canadian Recommendation Instrument: Accelerometer Actigraph GT3X and GTM1, observation of the school environment	15% of boys and 12% girls realized MVPA.
Henderson et al. 2015 ¹⁵	Sample Cross-sectional: 395 American Age group: 3-5 years American recommendation Instrument: Accelerometer Actigraph GTM1, observation and recording of routine/environment Frequency: 60 min MVPA/day	14% (average of 9 minutes) of children meet the recommendations. Sedentary behavior: 50%.
Tandon et al. 2015 ¹⁶	Cross-sectional: 98 American Age group: 4-5 years American recommendation Instrument: Accelerometer Actigraph GT3X Frequency: at least 60 min MVPA	73% of sedentary activities. 13% of light PA and 14% of MVPA.
Botey et al. 2015 ¹²	Cross-sectional: 631 Canadian Age group: 2-4 years Canadian recommendation Instrument: Questionnaire to parents Frequency: 180 min TPA/day	62% did not meet the recommendations. 64% exceeded the time devoted to TV.
Barbosa et al. 2016 ¹⁴	Cross-sectional: 370 Brazilian Age group: 4-6 years Canadian recommendation Instrument: Accelerometer Actigraph GT3X and questionnaire the school environment Frequency: 180 min TPA/day	10% achieved the recommendations. Sedentary behavior: 90%.

PA = Physical Activity; TPA Total Physical Activity; MVPA = Moderate and Vigorous Physical Activity. *Review articles and international recommendations were not included in the table.

The instruments for data collection were: Accelerometer ActiGraph GT3X²⁹; accelerometer (model not specified) and anthropometric measurements³¹; accelerometer ActiGraph GT1M and structured questionnaire to parents³³; ToyBox-intervention (six steps)³⁴; accelerometer (model not specified), motor test and anthropometric measurements and semi qualitative questionnaire to parents³²; accelerometer (model not specified) and instruction to teacher's³⁰; accelerometry (model not specified), body composition and instruction to teacher's³⁵.

All studies implemented daily PA, except De Bock et al.³¹ in which PA took place twice a week. The amount of PA time provided varied among 30, 35, 60, 120 and 180 minutes per day; De Bock et al.³¹ did not clarify this information.

An increase in PA levels was demonstrated in five studies; Goldfield et al.³⁵ and O'Dwyer et al.³³ documented the best results. They offered, respectively, 60 min/day and 180 min/day of activity, complying with the American²⁰ and United Kingdom²² determinations. Although the results were positive, in three studies, the estimated time

of the daily activity did not reach the minimum PA time recommended for preschool children. De Craemer et al.³⁴, was the only one study that did not obtain positive results. Study findings are shown in Chart 2.

The ages correspond to the age group proposed in preschool children, therefore it is in agreement with the expected parameters, and the PA was offered with different frequency, duration, intensity and quantity. The methods of determining the level of PA also varied. De Craemer et al.³⁴, Goldfield et al.³⁵ and Pate et al.³⁰ classified three intensity levels of PA, whereas Annesi et al.²⁹, Bock et al.³¹, O'Dwyer et al.³³ and Roth et al.³² analysed only one or two distinct levels.

As a result of these differences, appropriate comparisons among the studies cited are difficult, corroborating the conclusion by Timmons et al.²⁵ that there is no consensus as to the amount, type, frequency or intensity of PA proposed for preschool children.

However, a meta-analysis of Gordon et al.³⁶ on the effects of PA programmes for preschoolers determined that strategies with at least four weeks of intervention achieved positive results in raising moderate levels of PA in children. These interventions primarily involved changes in the environment and the introduction of outdoor activities³⁶.

Factors Associated with Physical Activity Practice in Preschool Children

Factors associated with PA levels among preschool children were analysed in 14 studies, nine of which referred to the factors of physical environment and socio-economic characteristics (Barros et al.¹³, Barbosa et al.¹⁴, Henderson et al.¹⁵, Tandon et al.¹⁶, Faria et al.²⁸, Bürgi et al.³⁷, Dawson-Hahn et al.³⁸, Olesen et al.³⁹, Vale et al.⁴⁰). Three studies referred specifically to parental or family factors (Loprinzi and Trost⁴¹, O'Dwyer et al.⁴², Remmers et al.⁴³). The other two examined issues of professional preparation (Androutsos et al.⁴⁴, Howie et al.⁴⁵).

Among the 14 studies, ten used questionnaires (validated questionnaire and adapted to Brazil¹³; structured form of daily preschool analysis^{14,28,43}; parental characteristics questionnaire^{37,38,40}; semi qualitative questionnaire³⁹; international physical activity questionnaire - IPAQ^{41,42}) and nine used accelerometers (ActiGraph GT1M^{15,37,38,40,42}; ActiGraph GT3X^{14,16}; ActiGraph GT1M and GT3X³⁹; ActiGraph 7164⁴¹) to associate environmental factors with PA levels and sedentary behaviour;

to identify the activities performed by children and discussed capacity strategies and the participation of parents and teachers. Chart 3 presents relevant details on these studies.

The studies identified the following as positive factors that contributed towards increasing or preserving children's level of PA: (a) recreational time; (b) time for outdoor activities; (c) physical space for games and recreation; (d) use of parks; and (e) indoor space for adapted games. Negative aspects included (a) rigid school routines; (b) overuse of academic activities that leave children in queues, sitting and waiting; (c) time spent playing with toys; (d) lack of space at home; (e) full-day school attendance; and (f) time spent watching television.

The availability of open space and a suitable environment is clearly essential to raise the level of PA among preschool children in educational or child-care settings, at home and in public areas^{15,16,43}. Another favourable step is to reserve dedicated time in school or elsewhere for children to move around^{14,28}.

Children's sedentary behaviour has been linked with the amount of time spent watching television³⁸, the absence of space for physical activities¹³, inflexibility in the school routine and a heavy emphasis on academic activities that require children to stay seated for long periods of time²⁸. This last practice is contrary to official recommendations, which discourage engaging children in sedentary activities for more than 60 minutes at a time²⁰⁻²³.

In studies related to professional factors, the following were associated with increasing or preserving PA levels: (a) suggestions and training models, capacity and professional qualification between universities and schools; (b) the teacher's actual participation in and encouraging children to engage in physical activities; and (c) planning and the choice of activities^{44,45}.

Although the literature has still not proven a direct relationship between training programmes for teachers and increased PA levels for preschool children, the case study conducted by Howie et al.⁴⁵ observed two teachers during three years of training, which enabled them to increase the PA opportunities offered to children.

Teachers' professional development and behaviour can influence the healthy habits of preschoolers, especially with regard to their practice of PA; this finding was reported by Ward et al.⁴⁶, in a review of studies on the daily behaviours adopted by teachers that contributed towards children's healthy development.

Chart 2. Program of physic activity with preschools children*.

Authors	Method	Results
Annesi et al. 2013 ²⁹	338 children Afro-American, 3-5 years, 2 months of intervention, 30 min/day of MVPA, accelerometer ActiGraph GT3X and control group.	Intervention group obtain an increase of 40 minutes per week of MVPA. Increased by the weekly program Star For life.
De Bock et al. 2013 ³¹	826 German parents and children 3-5 years, 1 year intervention control group, 2 times per week of PA, accelerometer (model not specified) and anthropometric measurements.	The program reduced sedentary behavior in 11 minutes/day. Involvement positive of parental in 15 projects to increase PA levels.
O'Dwyer et al. 2013 ³³	Intervention 60 min/day for 6 weeks: 240 English children between 3- 5 years. Accelerometer ActiGraph GT1M, questionnaire to parents control group. (British Recommendation).	The intervention doubled the MVPA levels compared to the control group from about 16% to 31%. The children who spend more time in schools showed lower levels of PA.
De Craemer et al. 2014 ³⁴	Toy-Box Intervention** of 2 months with 472 Belgian preschool children and 180min/day of PA. Control Group, accelerometer (model not specified).	There were not significant changes in the PA level of children. Only in upper-class boys there was a positive effect in MVPA.
Roth et al. 2015 ³²	Intervention of 6-month in 709 German children between 4-5 years. Control group, accelerometer (model not specified), motored test, and anthropometric questionnaire with parents. Instruction the PA offers to parents and teachers and 30 min/day of PA.	The intervention group was better the level of motor skills, increased about 1% in total time TPA.
Pate et al. 2016 ³⁰	Intervention 2 years: 379 American children of 4 years, control group. 35 min/day PA. Instructions the PA offer to teachers and accelerometer (model not specified).	The intervention group compared to the control obtained an increase from about 6% to 7% min/hour in MVPA.
Goldfield et al. 2016 ³⁵	Intervention of 6 months, 120 min/day of PA, (American Recommendation). 83 Canadian children between 3-5 years, the control group. Instructions the PA offer to teachers, accelerometer (model not specified) and body composition.	The intervention group showed an increase of about 22 minutes/day of PA, reducing the percentage of fat and fat mass.

PA = Physical Activity; TPA Total Physical Activity; MVPA = Moderate and Vigorous Physical Activity. *Review articles and international recommendations were not included in the table. **Toy-Box Study is a multidisciplinary intervention program of 6 steps to reduce and prevent childhood obesity through healthy eating, water intake, physical activity and combating sedentary.

In the studies related to family factors, those associated with increasing or maintaining high levels of PA included (a) parents' involvement and participation; (b) guidance booklets, information and instructions offered to parents; and (c) the availability of extracurricular activities^{13,41-43}. Factors shown to have a negative impact were (a) inadequate parental health habits or obesity^{37,38} and (b) higher level of parental education⁴⁰.

Loprinzi and Trost⁴¹ demonstrated promising results in terms of increased PA among children when the parents became participants in activities and projects developed by children in their school. Similarly, both O'Dwyer et al.⁴² and Remmers et al.⁴³ showed how parents' healthy life habits influence the behaviour and habits of children, both within and outside school, which con-

tributes to the review of Brown et al.⁴⁷ about of the involvement of the family to increase physical activity in children.

Barros et al.¹³ and Vale et al.⁴⁰ found an association between lower levels of child PA and higher levels of parental education, but Bürgi et al.³⁷ and Dawson-Hahn et al.³⁸ reported opposite results (higher level of parental education higher level of PA). Therefore, the interaction between the socio-cultural context and levels of PA should be further investigated.

The negative factors associated with PA levels of preschool children suggest the need for modifications of the institutional environment, not only in the structural and physical sense but also to provide better incentives and opportunities for children to develop, researches that use ecological models is necessary⁴⁸.

Chart 3. Studies about associate factors at absence of physical activity in preschool children*.

Authors	Method	Results
Bürge et al. 2010 ³⁷	Cross-sectional: 542 Swiss preschoolers of two culturally different. Instrument: accelerometer Actigraph GT1M, anthropometric measurements, motor skill and parental characteristics questionnaire.	The regions, maternal workload and parental education resulted in differences in PA, sedentary activities and agility.
Faria et al. 2010 ²⁸	Cross-sectional: 38 Brazilian preschool children. Instrument: structured form of daily preschool analysis to parents and ecological analysis of environment.	The rigid routine and time spent in queues, waiting or sitting prejudiced the PA levels. The supply of PA generated the development of proximal processes.
Loprinzi and Trost 2010 ⁴¹	Cross-sectional: 156 Australian parents and preschoolers. Instrument: IPAQ to parents and accelerometer Actigraph 7164.	Support and participation of parents about PA showed a positive correlation with increase PA levels of children.
Barros et al. 2012 ¹³	Cross-sectional: 265 Brazilian preschoolers. Instrument: validated questionnaire and adapted to Brazil to parents.	Absence of space in home, go to school full or vespertine period and higher education of parental showed correlated low levels of PA.
O'Dwyer et al. 2012 ⁴²	Cross-sectional: 77 English families of preschool children. Intervention: 5 sessions for 10 weeks approximately 70 min. Instrument: Questionnaire Pre-PAQ to parents, accelerometer Actigraph GT1M, control group, guidance to family.	The intervention group reduced sedentary behaviors and higher PA levels. Guidance and information to parents collaborated with healthy habits of their children.
Androutsos et al. 2014 ⁴⁴	Analyze capacitation Program of the Toy Box-Study Training* with 3 teachers of Greeks preschool children.	Training guided the construction of the training material Toy-Box study and generated efficacy, motivation and loyalty to the intervention program.
Olesen et al. 2014 ³⁹	Sample Cross-sectional: 627 Danish children of 5-6 years. Instrument: Anthropometric measures, Motor Scale, Accelerometer Actigraph GT1M and GT3X and semi qualitative questionnaire parents.	There was no difference of gender in relation to PA levels. The children were more active on weekdays in school.
Vale et al. 2014 ⁴⁰	Cross-sectional: 509 Portuguese children between 3-5 years. Instrument: parental education questionnaire and accelerometer Actigraph GT1M.	Negative correlation between parental education and PA level.
Remmers et al. 2014 ⁴³	Two-year follow-up: 2,007 parents of Dutch preschool children with 5 years. Instrument: structured form of daily preschool analysis to parents.	The habits and the presence of parents positively influenced the increase in the duration of external games by children.
Henderson et al. 2015 ¹⁵	Sample Cross-sectional: 395 American children between 3-5 years. Accelerometer Actigraph GT1M, routine observation and environmental characteristics.	14% of the time dedicated to PA. 3 factors raised PA: outdoor games, games adapted the covered space and encouragement of teachers.
Tandon et al. 2015 ¹⁶	Cross-sectional: 98 American children with a mean age of 4.5 years. Accelerometer Actigraph GT3X and observation.	<Sedentary time and> PA levels when in outdoor activities without teacher guidance.
Dawson-Hahn et al. 2015 ³⁸	Cross-sectional: 96 Latino-American children between 3 and 5 years. Questionnaire and accelerometer.	Parental education had a positive correlation with PA. And TV viewing was inversely associated with PA.
Barbosa et al. 2016 ¹⁴	Cross-sectional: 370 Brazilian preschool children 4-6 years. Instrument: structured form of daily preschool analysis to school director and accelerometer Actigraph GT3X	10% of the time dedicated to PA. The recreation room, the park and the recreational time had a positive correlation with PA.
Howie et al. 2016 ⁴⁵	Case Study: 2 teachers offered a training program during 3 years to increase the PA level of 8 American preschools	Increase in the time in observation minutes of PA opportunities offered by teachers.

PA = Physical Activity. *Review articles and international recommendations were not included in the table. **Toy-Box Study is a multidisciplinary intervention program of 6 steps to reduce and prevent childhood obesity through healthy eating, water intake, physical activity and combating sedentary.

The context in which the child is inserted must respect his or her individual characteristics, such as whether the child enjoys running. It should also encourage social relationships and diverse experiences in environments frequented by other children, both at school and elsewhere. The insertion of active play, as noted by Ginsburg²⁷, has been identified as a positive factor in encouraging PA among small children.

Limitations and Recommendations for Future Research

The points of uncertainty and disagreement that exist between official recommendations and between the methods used to detect and to improve PA levels do not seem to have benefitted scientific research in this area. They may also have held back efforts to devise strategies to combat sedentary lifestyles and increase PA among preschool children. Therefore, further discussion of these topics should take place.

The influence of parental education on children's PA remains to be clarified, as the results of existing studies were contradictory on this point; high levels of parent education were associated with high PA among preschool children in two studies and low PA in two others.

Although there is no consensus on what amount of time spent in a sitting position constitutes sedentary behaviour in children, there is evidence that the percentage of preschool children with inadequate PA time has increased in recent years. This lack of PA could damage their development as well as increasing their risk of various diseases. And contextual variables (family environment, school environment, the child and activities performed) have too that influence the PA levels of children. Consequently, an increase in PA among preschoolers is urgently required, and public policy should encourage this change.

To construct efficient policies and to design actions that will lead to increased PA, it is essen-

tial to better understand how preschool children experience different aspects of PA. Therefore, more research should be conducted on contextual variables related to PA among preschoolers.

Conclusions

Existing studies have contributed to our knowledge of preschool children's level of PA; they have shown the impact of the implementation of various PA programmes in preschools and have revealed factors associated with PA among preschool children.

There is lack of studies of the minimum time of PA ideal for preschool children. However, the risk of sedentary behaviour among preschoolers has increased during the period between 2006 and 2016, regardless of the frequency level applied.

The implementation of some PA programmes has succeeded in increasing children's average PA time, even though the amount of PA provided was still below official recommendations in some cases. Such programmes had different methodologies and varied with regard to the amount, frequency, intensity and type of PA offered. The approaches to assessing levels of PA and the strategies to improve PA levels also were differed.

Low levels of PA for preschool children were associated with various contextual variables: lack of stimulation at home and at school, lack of time and space to play outdoors, infrastructure problems and resources in schools, rigid routines and time spent watching television or using other electronic devices (computers, tablets and cell phones).

Accordingly, teachers, parents and other segments of society should be encouraged to discuss strategies, criteria and recommendations the adoption of which will increase the PA level of preschool children.

Collaborations

VAC Coelho was responsible for stratification, the reading of the articles and the assembling of the text. RE Tolocka was responsible for checking the stratification, methodology and final writing.

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