Motor development according to nutritional status in preschoolers

Desarrollo motriz según el estado nutricional de preescolares chilenos

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Abstract

The objective of the study was to compare motor development according to nutritional status in children aged 3 to 5 belonging to "JUNJI" nursery schools from Valparaíso, Chile. It is a descriptive study with a non-probabilistic sample for convenience, composed of 136 preschoolers (girls n=70 and boys n=66) with a mean age of 3.67 ± 0.40 years. The body mass index (BMI) was calculated based on the formula extracted from weight and height, expressed in kg/m2 and nutritional status was classified based on international indications described by the World Health Organization (WHO). Motor development was identified and classified with the Test of Gross Motor Development (TGMD-2).

A comparative analysis was performed according to gender and nutritional status. Preschoolers tested mainly between the levels of motor development "very poor", "poor", "low average" and "average". No preschooler was placed at the "very high" level. No significant differences were found according to gender and nutritional status for the motor development variable. Girls in overweight/obesity categories showed a lower motor development than girls in low weight/normal weight categories, a situation that was not shown among boys.

Key words: physical education, motor development, body mass index, childhood.

Resumen

El propósito de este estudio fue comparar el desarrollo motriz según estado nutricional en niños y niñas de 3 a 5 años de edad pertenecientes a jardines infantiles JUNJI, de la región de Valparaíso, Chile. Estudio descriptivo con una muestra no probabilística por conveniencia, compuesta por 136 prescolares (niñas n= 70 y niños n=66) con edad promedio de 3,67 ± 0,40 años. El índice de masa corporal (IMC) se calculó en base a la fórmula entre el peso y talla, expresados en kg/m2 y se clasificó a partir de las indicaciones internacionales descritas por la Organización Mundial de la Salud (OMS). El desarrollo motriz se identificó y clasificó con el Test de desarrollo motriz (TGMD-2). Se realizó un análisis comparativo según género y estado nutricional. Los preescolares se ubican mayoritariamente entre los niveles de desarrollo motriz "muy pobre", "pobre", "bajo promedio" y "promedio". Ningún preescolar se ubico en el nivel "muy superior". No se encontraron diferencias significativas (p < 0,05) según género y estado nutricional para la variable de desarrollo motriz. Las niñas en categorías de sobrepeso/obesidad presentan un desarrollo motriz más descendido que las niñas en categorías de bajo peso/normopeso, situación que no se repite en los varones.

Palabras clave: educación física, desarrollo motriz, índice de masa corporal, infancia.

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Introduction

Child malnutrition has transformed in one of the century's most important public health problems. In 2016 the World Health Organization (WHO) stated that the prevalence has increased at an alarming rate (López et al., 2020; Monacis et al., 2022). It was estimated that in 2016 more than 41 million children worldwide under the age of five were obese or overweight, posing a worldwide health problem that continued until adulthood. Berleze and Valentini, (2022) showed that obesity is increasing worldwide, it affects girls' and boys' health and also their motor development and other areas linked to physical activity. Currently, in Chile, the health condition is very alarming since 45% of children are overweight or obese (OCDE, 2019), ranking as one of the countries with more overweight population in Latin America. In 2013, it was reported that 23.7% of children under the age of six was overweight and 10.3% were obese (Ministerio de Salud, 2016). This situation has not changed, currently the Nutritional Map 2020 published by the National Scholarship and School Aid (JUNAEB, 2020) pointed out that children aged 5-6 (preschool age) were overweight (22.5%), obese (11.6%) or severely obese (11.6%).

On the other hands, the Agencia de Calidad de la Educación (Quality in Education Agency) (2016), states that the high indicators of overweight and obese children have been influenced and affected by a detriment in healthy lifestyle habits. This situation is a common and transversal scenario since, in all educational levels of the country, subjects surpass the normal weight average. This organization points out that boys and girls have developed a poor diet and a sedentary and unhealthy lifestyle. Hesketh and Cambell, (2010) y Cano et al., (2014) mention that the most common factors that contribute to obesity in early childhood (0-5 years old) are the intake of high-calorie foods and performing activities of low energy consumption. Cano et al., (2014), states that low energy activities are watching TV, using the computer, doing homework, reading or listening to music; activities that mark a low level of physical activity. In connection to that, Tavalera, (2011) indicated that those children who spend more time playing in the computer, video games, or in front of the TV have a higher probability of suffering from obesity or being overweight than those children who are more physically active.

According to Martí (2011), sedentary behavior is in itself a category of physical activity characterized by a scarce or null energetic consumption in comparison to basal level. Just like other factors, sedentarism is a modifiable risk factor, which means that a lifestyle that includes the practice of physical activities must be followed. Martínez-Hita et al., (2021) points out the concerning decrease of physical activity as the school age goes up. Physical activity contributes to the reduction of suffering from coronary and cardiovascular diseases, colon cancer, non-insulin dependent diabetes mellitus, high blood pressure and obesity; it contributes in keeping a good weight, increases bone density, strengthen muscles, and improves mental health, increasing self-esteem levels, and lowering levels of anxiety, depression, and stress (Casado, 2009; Dimitri et al., 2020; Donelly et al., 2016). It also shows benefits in sociability and social integration during childhood, it improves the maturation of the motor nervous system, it improves motor skills, and it improves academic performance in school.

Childhood, particularly, is considered a fundamental stage in the development of the human being (Coromoto et al., 2011). It is the source of several significant processes that last in time, specially between 2 to 5 years old. This period is a stage known for the motor development in children, and its special importance in later stages. It is also identified as a sensitive period for promoting healthy lifestyle habits (Aliño et al., 2007; Pereira et al., 2021).

Focusing even more this problem in the area of physical activity and considering the children's motor development, in this period important milestones in their motor behavior occur; mainly the skills of dynamic coordination are developed, which are essential for almost all of the activities people perform in their daily life (Berruezo, 2000; Zeng et al., 2017). This process of motor formation is mentioned by Campo (2010) as a continuum in which the child gradually acquires complex activities which allow them to interact in different ways with people, objects and situations in their surroundings. For that matter, processes such as growth, maturation, adaptation and learning make possible the development of the human being, forming their identity in biopsychosocial aspects.

In this life stage is where a progressive advance can be seen, from reflex movements to the development of basic or fundamental motor skills. These last ones are considered indispensable for the participation in motor activities and for the progression in specific motor skills. Haywood and Getchell, (2001) and Cano et al., (2015) name these basic motor skills as the foundation that conduct to more complex movement sequences. Lopez (2013) states that this is an exceptional moment to consolidate the control of basic motility in students. However, this evolutive process is a stage that is affected by a series of both endogenous and exogenous factors where the subject's motor development is affected by different structural characteristics and a strong influence of anthropometric characteristics (Kakebeeke et al., 2021). Méndez et al., (2015), point out that the body max index (overweight/obese) is a factor that negatively affects the motor development in preschoolers. In the same way, Bucco and Zubiaur (2015) mention that obese and overweight children perform and present a motor competence lower to the one expected for their age: in balance, sprint, lateral sprint, jump, galloping, throw, catch, kick and hit a ball. Páez et al., (2020) and Drenowatz et al., (2022)an increasing number of children display poor physical fitness and high body weight. The aim of this study was to examine the prospective association of physical fitness with body weight throughout the elementary school

years with a special emphasis on children with high body weight or poor physical fitness at baseline. A total of 303 Austrian children (55.1% male state that a high index of body mass negatively affects the motor development of preschoolers. In the same way, Cigarroa et al., (2016), points out that overweight and obese children show fewer skills in the motor development and indicates that, unfortunately, over the last few years, children and adolescents perform fewer physical activities, making this inactivity one of the main causes of increase in body weight and, at the same time, a poor motor competence in children (Sedehi et al., 2021). In the same lines, overweight and obesity are critical factors in the development of fine motor skills in preschoolers (Cenizo- Benjumea et al., 2017; Rudisill, 2011; Oliveira et al., 2011; Almeida et al., 2012; Bardid et al., 2013; Mathisen, 2016; Bustamante et al., 2008; Willian et al., 2008; Méndez et al., 2015). In addition, Lepes et al., (2014), mention that the human body is complex, comprised of many tissues that change as the body develops, matures and grows old. It is also mentioned that human capacities and constitution are continuously changing in a relatively constant manner, consistent with the known laws of development, significantly affecting bodily composition and also the development of motor evolution (Molina-Garcia et al., 2020)but there is little evidence to date. Research Question: Is physical performance (i.e., physical fitness and functional movement.

For the reasons mentioned above, the objective of the study was to compare the motor development according to the nutritional status of boys and girls aged three to five who attended nursery schools from the JUNJI (National Board of Nursery Schools) in the region of Valparaíso, Chile.

Material and Methods

Participants

Descriptive study with a non-probabilistic sample for convenience, a total of 136 preschoolers (girls= 70; boys= 66) from four nursery schools from the National Board of Nursery Schools (JUNJI) in Valparaíso (V Region) Chile were part of the study. Age ranged from 3 to 5 with a median of 3.67 ± 0.40. In connection to weight, boys weighted 17.79 kgs. (*ds*= 2.64), and girls 16.79 kgs. (*ds*= 2.45). In connection to height, boys had an average size of 101 cm. (ds= .05), and girls 99 cm. (.05).

The group was distributed as follows: Nursery school N°1(n= 50), Nursery school N º2 (n= 36), Nursery school N º3 (n=30) and Nursery school **Nº4** (n=20). Named numerically and correlatively in order to protect the information of the participant organizations.

Instruments

The application of the instrument was performed considering the ethical principles for research in humans proposed by the Helsinki declaration (World Medical Association, 2013) and the suggestions of procedures and documentation of the Research Directorate of the Pontifical Catholic University of Valparaíso through the Scientific and Bioethical Ethics Committe (BIOEPUCV-H158-9-12-2018), the authorization from the authorities of the nursing schools was requested to later send an informed consent to the parents/tutors, mentioning the objectives and scope of the study so as to authorized their child's participation.

To determine de nutritional status of the participants (low weight, regular weight, overweight and obesity) the Body Mass Index (BMI) was used, to determine size a portable height rod was used (Bodymeter 206 Seca) and a digital scale (Scale plus Body Fat Monitor UM-028, TANITA) was used to measure weight. Size and weight were measured and expressed in kg/mts^{2,} and body composition was identified following the directions stated by the Health Ministry (2016) for the nutritional evaluation of boys and girls aged three to five. Two groups were formed: low weight / regular weight and overweight / obesity group. For the BMI evaluation, all children were weighted and measures with no shoes on and a comfortable t-shirt. This process was monitored by the teacher responsible of teach particular group/class.

In order to identify the level of motor development of the participants the instrument Test of Gross Motor Development (TGMD-2) was used (Ulrich 2002). The objective of this instrument is to assess the motor development in boys and girls between the ages of three to 10 years, categorizing motor behavior in seven categories: very poor, poor, below average, average, above average, superior, and very superior. 12 basic motor skills are grouped in two subtests: locomotor skills and object manipulation or control. Each task is assessed under criterion according to efficacy and execution performance, where a score of one is given if it is done correctly and a zero if not. The assessment was carried out in a spacious and flat area, free of obstacles. All boys and girls performed each of the tasks wearing comfortable clothes, and the tests were applied individually, starting with the locomotor tests, which were applied in the following order: run, gallop, hop, leap, horizontal jump and slide. Next, the tests of Object Control were applied in the following order: strike, dribble, catch, kick, throw and roll. After the test application and adding the two tries per test, the scores must be analyzed with ethe conversion chart according to the children's age in months. This gives a score denominated standard score which describes the gross motor skill, which then provides according to their motor sills range: very superior (> 130), superior (121-130), above average (111-112), average (90-110), below average (80-89), poor (70-79) and very poor (< 70).

Statistical Analysis

For the statistical analysis of the results, a comparative analysis is performed according to sex and then the nutritional status is categorized under two groups (low weight / regular weight vs overweight / obese). The media and standard deviation were used to describe the variables.

For the test of regular distribution, Kolmogorov-Smirnov (n >30) was used, then the nonparametric U of Mann Whitney (Wilcoxon) to test the homogeneity of the samples, and to check the statistical significance with a confidence level of 95% (p< .005).

The software IBM SPSS Statistics 24 (New York, USA) was used to carry out the statistical analysis.

Results

Table 1 shows general results according to the sex of the participants gathered from the anthropometric variables and motor development, where boys show a superior means in all the variables connected to motor development and BMI in comparison to girls. However, there is only one significant difference in the weight variable. Table 2 shows the results obtained in comparison to the low weight / regular weight group in connection to the overweight / obese group in girls (n= 70) and boys (n= 66). The girls in the low weight / regular weight group (n= 37) showed a better punctuation in locomotion and manipulation compared to the girls in the overweight / obese group (n= 33). Unlike the boys, where the overweight / obese group (n= 38) showed a better score than the boys in the lower weight / regular weight group (n= 28).

Table 1. Median, standar deviation and p value of basic variables and motor skills comparison between girls and boys

Variable	Girls (n= 70)	Boys (n= 66)	*p value*	Total (n= 136)
Age (years)	3.69 ± 0.41	3.66 ± 0.39	*.719*	3.67 ± 0.40
Weight (kg)	16.79 ± 2.45	17.79 ± 2.64	*.016**	17.27 ± 2.58
Height (mts)	.99 ± 0.05	1.01 ± 0.05	*.063*	1.00 ± 0.05
BMI (W/H²)	16.94 ± 1.79	17.41 ± 1.94	*.171*	17.17 ± 1.88
Movement score	8.79 ± 2.45	9.67 ± 2.60	*.149*	9.21 ± 2.55
Manipulation score	9.81 ± 2.64	10.32 ± 2.67	*.166*	10.06 ± 2.66
Sum of the scores	18.60 ± 4.42	19.98 ± 4.22	*.116*	19.27 ± 4.36
Motor coeficient	95.80 ± 13.25	99.95 ± 12.67	*.116*	97.82 ± 13.09

* Significant diferences with p value < .05 (IC-95%).

Table 2. Median, standar deviation and p value of basic variables and motor skills comparison of low weight/ regular weight group and overweight / obese group in boys and girls

Variable	Girls (n= 70)			Boys (n= 66)		
	Low weight – Regular weight (n= 37)	**Overweight - Obese (n= 33)**	***p value***	**Low weight – Regular weight (n= 28)**	**Overweight - Obese (n= 38)**	***p value***
Weight (kg)	15.48 ± 1.63	18.25 ± 2.40	*,000**	16.10 ± 1.52	19.03 ± 0.61	*.000**
Height (mts)	0.99 ± 0.04	1.00 ± 0.06	*,340*	1.01 **±** 0.05	1.01 ± 0.04	.599
BMI (W/H²)	15.64 ± 0.86	18.30 ± 1.41	*,000**	15.87 ± 0.67	18.54 ± 1.78	*.000**
Movement score	8.92 ± 2.14	8.64 ± 2.79	*,612*	9.32 ± 2.26	9.92 ± 2.82	*.425*
Manipulation score	10.08 ± 2.71	9.52 ± 2.58	*,376*	9.79 ± 2.81	10.71 ± 2.52	*.083*
Sum of the scores	19.00 ± 4.02	18.15 ± 4.85	*,411*	19.11 ± 4.15	20.63 ± 4.21	*.152*
Motor coeficient	97.00 ± 12.06	94.45 ± 14.55	*,411*	97.32 ± 12.45	101.89 ± 12.64	*.152*

* Significant diferences with p value < .05 (IC-95%).

Table 3 shows the group of girls according to their BMI groups and location according to their motor development. There are not girls, from any group, placed in the very superior category, most of the girls in both groups are in the average level. Girls in the overweight / obese category showed a lower performance, showing a 27.3% lower performance than the required for their age. On the other hand, girls with low weight / regular weight showed a superior performance, hence 16.2% were placed above the average, unlike the overweight / obese girls where only 12.2% were placed in above average categories.

Table 3. Motor classification of the girls group according to nutritional status

Motor development level category.	Low weight – Regular weight (n=28)			Overweight - Obese (n=38)		
	N°	%	% acumulado	N°	%	% acumulado
Very poor	0	0	0	0	0	0
Poor	3	1.7	10.7	1	2.6	2.6
Below average	5	17.9	28.6	5	13.2	15.8
Average	16	57.1	85.7	23	60.5	76.3
Above average	3	10.7	96.4	4	10.5	86.8
Superior	1	3.6	100	5	13.2	100
Total	28	100		38	100	

Finally, Table 4 shows the results of the children, where most of them are at the average level; overweight/obese children show superior motor development, with over 23% at above-average levels.

Table 4. Motor classification of the boys group according to nutritional status

Motor development level category.	Low weight – Regular weight (n=37)			Overweight - Obese (n=33)		
	N°	%	Cumulative %	N°	%	Cumulative %
Very poor	1	2.7	2.7	2	6.1	6.1
Poor	3	8.1	10.8	4	12.1	18.2
Below average	3	8.1	18.9	3	9.1	27.3
Average	24	64.9	83.8	20	60.5	87.8
Above average	4	10.8	94.6	2	6.1	93.9
Superior	2	5.4	100	2	6.1	100
Total	37	100		33	100	

Discussion

In connection to the results in function to sex variable, out of the 136 assessed preschool boys and girls, it was possible to observe that there were no significant differences between them in the variables of motor development score (locomotion and manipulation). This is possible to explain using the information from Cenizo - Benjumea et al., (2019) who point out that it is possible to identify motor development differences between boys and girls since they are 10 years old.

When dividing the sample according to sex, girls (n= 70) did not show significant differences in the motor development variable according to their nutritional status, the same occurred in boys (n= 66). García et al., (2019) results are similar to the ones presented in this study, since there is a prevalence in overweight and obesity, independent from sex. It is also impossible to see statistically significant differences between both groups. Likewise, the results show that boys have a higher motor performance than the girls, independent of their nutritional status. Ruzbarska, (2020)there has been increasing evidence that motor competence is crucial for developing an active and healthy lifestyle. Objective: The purpose of the study was to investigate gross motor coordination in overweight and obese children compared with normal-weight peers. Methods: Data were collected in 326 children (160 boys, 49.1% concluded that, when comparing the motor skills development of children categorized as obese and overweight to those categorize as regular weight, children with regular weight showed better scores in the subtests of hopping, horizontal jump, and also in the motor coefficient. To Ribeiro Bandeira et al., (2020)Second Edition (TGMD-2 sex and BMI are variables that can determine the performance level in tests of motor development, specially in those that demand strength, balance, and synchronized movement of legs, torso and arms, such as the skills of throwing above the shoulder and kick. In these tests, boys have a higher score than girls, mainly for contextual situations and cultural motor practices.

In terms of the results of motor development according to their nutritional status, the analysis in the girls group indicates that 87.9% (n= 29) with overweight / obese show development levels of “very poor”, “poor”, “below average”, and “average”, exhibiting 4.1 percentual scores higher than the low weight / regular weight groups of the same development levels. These results are in line with the ones mentioned by Herrera et al., (2020) who evaluated the motor development and the connection of the BMI of 6 to 10 years old students, mentioning that 52.3% of overweight / obese girls shows a very poor motor development.

Solo un 12.2% (n= 6) de las niñas con sobrepeso y Only a 12.2% (n= 6) of the overweight girls show a motor development "above average" and "superior", value that increases in 4% in the group of low / regular weight. In the case of the boys the situation is different:76.3% (n= 29) with overweight / obesity show development levels from "poor" to "average", while the groups low / regular weight, the same development levels show an 85.7% (n= 24). In the categories of "above average" and "superior", the group od low / regular weight showed a 14.3% (n= 4), which is surpassed by a 9.4% (n= 9) in the obese / overweight group. It is worth mentioning that there are not children with a motor development of "very poor". For Méndez et al., (2015) who compared the psychomotor development in Chilean preschoolers to those children with obesity / overweight applying the Test of DMS TEPSI in a sample of 58 preschoolers aged four, which were divided into three groups: Regular weight (n= 28); Overweight (n= 18) and Obese (n= 12). In their results, 48.2% of preschoolers were categorized as regular weight, 31% as overweight and 20.7% as obese. This is very similar to the percentual order of the results obtained in this study. However, in regards to DMS, 100% of the preschoolers classified as "regular weight" showed a normal DMS and, in regards to the sample connecting motor behavior and BMI, a 97.4% of the participants categorized as normal state were placed between the "average" to "superior" level, only a 2.6% showed a motor development categorized as "poor". In the same way, there is an 88.8% of children who are overweight that got a normal DMS and an 11.12% of the children have a DMS with risk of delayed development. Lastly, in the last category of the mentioned study, it shows that, of the total of obese children, 75% shows a normal DMS and 25% has a risk of delayed development. These data can be compared with the information presented in this research, where 60.6% of the subjects with nutritional status of overweight / obesity show a motor development in the category "average". García et al., (2019) also mentions that children in regular weight show a better motor performance than compared to their overweight / obese peers. It also mentioned that girls with overweight / obese prevalence, only surpassed their peers with regular weight in the throwing test. Those results are a match to ones presented in this study. In this regard, they mention that these results can be explained using morpho-functional and environmental factors. Likewise, it is stated that the differences according to sex are explained due to the fact that girls have a lower perception of the motor competence they actually possess, which leads to the adoption of hypoactive behavior, which are reinforced by a family environment that limits the access to motor practices that boost motor control and development.

Meanwhile, Cenizo- Benjumea et al., 2017; Rudisill, 2011; Oliveira et al., 2011; Almeida et al., 2012; Bardid et al., 2013; Mathisen, 2016; Bustamante et al., 2008; Willian et al., 2008; Méndez et al., 2015, mention that children in a state of overweight and obesity present a decreased motor estate which concurs with the results of this study, particularly in the girls group; and opposite case in the boys group. About that, García et al., (2019), state that the poor performance in motor development tests in overweight / obese girls is also explained by the deficit of physical activity, results of the restricted access they have due to their condition.

Likewise, the results indicated that the assessed preschoolers (n= 136) present an average motor development and in second place below the average. Only a very low percentage presents levels above average and superior, and no preschooler is placed in the very superior category. This shows that a current proposal should be based in improving the gross motor skills of children in order to include larger areas of practice (Ochoa-Martínez et al., 2020)coordinación motriz gruesa y coordinación motora total de niños y niñas de prescolar. El diseño del estudio fue descriptivo comparativo, con muestreo por conveniencia, participaron 179 niños y niñas de una edad promedio de 4 y 5 años matriculados en jardines de niños para educación preescolar de la ciudad de Mexicali, Baja California, México. Se utilizó como instrumento de evaluación el inventario de desarrollo Battelle para determinar la coordinación motriz fina, coordinación motriz gruesa y coordinación motora total. La igualdad de la varianza se calculó mediante la prueba t Student para muestras independientes, resultando por género menor a $\alpha \leq 0.05$; la coordinación motriz gruesa (P-Valor=.000. This could be an appropriate objective to improve the general levels of physical activity, improving the motor behavior for future stages (Sánchez et al., 2017). In regards to early intervention, nowadays children do not spend a lot of time physically active, a study performed in Canadian children showed that they are not physically active enough to a healthy development and that only 9% of boys and girls meet the recommended levels of physical activity (Colley et al., 2012). It is in this context that the school yard become the main area to promote physical activities and the practice of motor skills (Lim et al., 2017). The education area of Physical Education plays a fundamental role to boost the motor development and modify the current scenario. The development of public policies that increase the class time in the Chilean educational system is strongly suggested; starting with mandatory classes from the first education stages in nursery schools throughout the country.

Conclusion

After doing the analysis of the results obtained, it is concluded that boys and girls of both groups are in an average state in their motor development. Comparing girls to the nutritional state of low weight / regular weight and overweight / obese, the later present mainly a lower motor development, placing them in the categories of "very poor", "poor", "below average" and "average". In this situation there is no evidence in the comparison of boys in

both groups according to BMI, where boys with overweight / obesity showed slightly better results.

There were no significant differences (*p value* .005) between the nutritional status (low weight / regular weight and overweight / obesity) and sex variable, for the factors of locomotion, manipulation and general level of motor development, which is why it is necessary to treat these results with caution and move forward in the finding of larger evidence in this age group.

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