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The effects of breakfast consumption on concentrated and distributed attention levels: a cross-sectional study with Brazilian school children of the public school system

Los efectos del consumo del desayuno en los niveles de atención concentrados y distribuidos: un estudio transversal con escolares brasileños del sistema escolar público

Os efeitos do consumo do café da manhã nos níveis de atenção concentrada e distributiva: um estudo transversal com escolares brasileiros da rede pública de ensino

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ABSTRACT

Attention is a very important aspect for school and physic performance and, regular breakfast consumption has been associated with better student performance. In addition, adequate glycemia levels are related to better quality of life. Therefore, the purpose of this study is to analyze the effects of breakfast consumption and glycemia levels on concentrated and distributed attention levels of high school students. This is a quantitative and cross-sectional research. The sample was composed by 54 students with average ages of 16 ± 0.89 , regularly enrolled in high school at an institution of the public school system. For this research we used the following data collection instruments: I) food records; II) capillary blood glucose testing with electronic device; III) Toulouse-Piéron's concentrated attention test, and; IV) Grid-type test. The data was collected on visits to the research site from 8:00 a.m. and 9:00 a.m. The sample was divided into fed group (who had breakfast) and fasting group (who had no breakfast). The fed group showed statistically better results for glycemia levels (87.25 ± 14.76 mg/dl), concentrated attention (116.21 ± 36.49 points), and distributed attention (20.89 ± 4.08 points). Mild correlations between the glycemia and attention levels were found. The results suggest a positive association between breakfast consumption and glycemia levels adequate to health with concentrated and distributed attention levels.

Keywords: Glycemia, Attention, Concentration, Adolescents.

RESUMEN

La atención es un aspecto muy importante para el desempeño escolar y, el consumo regular de desayuno se ha asociado con un mejor desempeño de los estudiantes. Además, los niveles adecuados de glucemia están relacionados con una mejor calidad de vida. Por lo tanto, el propósito de este estudio es analizar los efectos del consumo de desayuno y los niveles de glucemia en los niveles de atención concentrada y distribuida de los estudiantes de secundaria. Se trata de una investigación cuantitativa y transversal. La muestra estuvo compuesta por 54 estudiantes

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con edad promedio de 16 ± 0.89 , matriculados regularmente en la escuela secundaria en una institución del sistema escolar público. Para esta investigación utilizamos los siguientes instrumentos de recolección de datos: I) registros de alimentos; II) prueba de glucosa en sangre capilar con dispositivo electrónico; III) Prueba de atención concentrada de Toulouse-Piéron, y; IV) Ensayo tipo cuadrícula. Los datos se recolectaron en visitas al sitio de investigación de 8:00 a.m. a 9:00 a.m. La muestra se dividió en grupo alimentado (que desayunó) y grupo en ayunas (que no desayunó). El grupo alimentado mostró estadísticamente mejores resultados para los niveles de glucemia ($87,25 \pm 14,76$ mg / dl), atención concentrada ($116,21 \pm 36,49$ puntos) y atención distribuida ($20,89 \pm 4,08$ puntos). Se encontraron leves correlaciones entre la glucemia y los niveles de atención. Los resultados sugieren una asociación positiva entre el consumo de desayuno y los niveles de glucemia adecuados a la salud con los niveles de atención concentrada y distribuida.

Palabras clave: Glucemia, Atención, Concentración, Adolescentes.

RESUMO

A atenção é um aspecto bastante relevante para o rendimento físico e escolar, do mesmo modo, o consumo regular do café da manhã tem sido associado ao melhor desempenho de estudantes. Em complemento, índices adequados de glicemia estão relacionados a melhor qualidade de vida. Portanto, a presente pesquisa tem como objetivo analisar o impacto do consumo do café da manhã e dos índices de glicemia nos níveis de atenção concentrada e distributiva de escolares do ensino médio. A pesquisa caracteriza-se como quantitativa e transversal. A amostra foi composta por 54 escolares com idade média de $16 \pm 0,89$, regularmente matriculados no ensino médio de uma instituição da rede pública de ensino. Foram utilizados como instrumentos de coleta de dados: I) recordatório alimentar; II) teste de glicemia capilar por dispositivo eletrônico; III) teste de atenção concentrada de Toulouse-Piéron e; IV) teste do tipo Grelha. Os dados foram coletados em visitas ao local de pesquisa entre às 08h00min e 09h00min. A amostra foi dicotomizada em grupo alimentado (que consumiu café da manhã) e grupo jejum (sem consumo de café da manhã). O grupo alimentado apresentou resultados estatisticamente melhores de índice de glicemia ($87,25 \pm 14,76$ mg/dl), atenção concentrada ($116,21 \pm 36,49$ pontos) e atenção distributiva ($20,89 \pm 4,08$ pontos). Foram identificadas correlações leves entre o índice de glicemia e os níveis de atenção. Os resultados sugerem uma associação positiva entre o consumo do café da manhã e índices de glicemia adequados à saúde com os níveis de atenção concentrada e distributiva.

Palavras chave Glicemia, Atenção, Concentração, Adolescentes.

INTRODUCTION

The biological, social, and behavioral alterations are part of the adolescents' routine, interfering on this population's food habits (Coêlho, Macedo, & Pereira, 2017). The reflex of a poor diet at this age can be decisive for present and future health problems, such as childhood obesity, a known public health problem that can result in psychosocial, endocrine, cardiovascular, gastrointestinal, renal, neurological, lung and musculoskeletal disorders (Fisberg, Previdelli, Del'Arco, Tosatti, & Nogueira-de-Almeid, 2016; Han, Lawlor, & Kimm, 2010). Known as the amount of glucose found in the blood, glycemia has a close connection with diet, being a relevant aspect in the life of young people, as a good diet control can favor life quality (Ribeiro et al., 2011).

A healthy eating routine throughout adolescence is of major importance for a better quality of life and the prevention of non-transmissible diseases during adulthood (Fisberg et al., 2016). In this sense, having an adequate diet can provide several other health benefits, as good eating habits are positively associated to a healthy life style (Trancoso, Cavalli, & da Costa Proença, 2010). Although, in general, eating well is essential, the breakfast is the main meal of the day, this way, its regular consumption helps favorable nutrient intake, promoting, for example, improvement on learning, cognition and school and physic performance (Deshmukh-Taskar et al., 2010; Höfelmann & Momm, 2014; Hoyland, Dye, & Lawton, 2009).

However, adolescents commonly skip meals, and as an aggravating factor, breakfast is the most neglected meal at this age, which can explain the high

occurrence of eating disorders at this phase of life (Gambardella, Frutuoso, & Franch, 1999; Rampersaud, Pereira, Girard, Adams, & Metzl, 2005; Sturion, Da Silva, Ometto, Furtuoso, & Pipitone, 2005). The regular consumption of breakfast is associated to improvement on the cognitive and physic performance, attention and memory of students and school regularity of children and adolescents (Affenito, 2007; Höfelmann & Momm, 2014; Rampersaud et al., 2005; Rampersaud, 2009). This way, it is evident that eating habits have an important role in the brain and cognitive development, interfering in the learning through factors relevant to classroom tasks, such as the psychological capacities (Pontes, Luz, Luz, & Passoni, 2010).

Among the superior psychological capacities, attention has a high degree of conceptual complexity (Hernández-Mendo, Martínez-Jiménez, Pastrana-Brincones & Morales-Sánchez, 2012), but it can be understood as a selective, intensive and directed state of perception, if configures a psychological capacity of great relevance for school and sports performance (Memmert, Simons & Grimme, 2009; Samulski, 2009). When information stimulates the senses, attention acts as a focus guide, through a process of encouraging exclusive and guided perception, having a close relation with other mental actions, such as memory and action planning, whether motor or not (Benczik, Leal, & Cardoso, 2016; Da Silva & Piscinato, 2018; Gertsenchtein, 2011; Pérez-Lobato, Reigal & Hernández-Mendo, 2016; Samulski, 2009; Vygotsky, 2003).

In this context, different forms of attention manifest according to the characteristics of the individual, like those of concentrated attention that are based on the individual's capacity to select important environment stimuli, focusing only them, and distributed attention, which is the separation of perception into various points (Samulski, 2009). Concentrated attention issues can make difficult to record learning and memory events, in the same way, the lower ability of team sports athletes to understand the movement of their teammates can be due to the lack of distributed attention (Braga, 2007; Samulski, 2009).

When considering the importance of attention to school performance (Affenito, 2007; Rampersaud et al., 2005), its relationship with physical activity is well documented (Memmert, Simons & Grimme, 2009; Pérez-Lobato, Reigal & Hernández-Mendo, 2016;

Reloba-Martínez, Reigal-Garrido, Hernández-Mendo, Martínez-López, Martín-Tamayo & Chiroso-Ríos, 2017; Samulski, 2009) and the need for adequate eating habits (Fisberg et al., 2016), especially breakfast (Dashmukh-Taskar et al., 2010), the present research aims to analyze the impact of breakfast consumption and blood glucose levels on the levels of concentrated and distributive attention in high school students. As the influence of eating habits in the psychological capacities (Hoyland et al., 2009) is already identified, the hypothesis presented in this study is that breakfast consumption and the higher glycemia level are associated with better concentrated and distributed attention levels.

MATERIAL AND METHODS

Sample

This study assessed 54 adolescents, brazilian public school students, from both sexes (M=19/ 35.2%; F= 35/ 64.8%) with average age of 16 ± 0.89 years old. The research site was intentionally determined as it offered classes during the morning period. 7 (seven) participants were excluded due to errors in the filling of the research instruments. A calculation of the sampling power was carried out by the G*Power 3.1.9.4 program, from an effect size of 0.5 and significance of 0.05, indicating post hoc values of $\beta = 0.81$ and 0.91, meeting the minimum criteria recommended by literature (Thomas, Nelson, & Silverman, 2012). The Research Ethics Committee of Instituto Federal do Paraná – IFPR approved this research through Opinion N. 2.303.279.

Instruments

For the data collection, we used four instruments. By means of a food record (last 12 hours), we identified the descriptive characteristics of the sample, as well as the information on the participants' last meal. We measured the glycemia levels with an AccuChek Active (Accu-Chek®, 2008) device, which expresses said index in milligrams per deciliter of blood (mg/dl). Capillary blood was collected from the procedures indicated in the equipment manual: I - wash the fingertip of the person evaluated with neutral soap and water; II - insert the test strip into the device and wait for the initial reading; III – insert the lancet into the lancing device, position it on the chosen finger and activate it to perform the puncture; IV – place the drop of blood on the test strip and wait for the result; V –

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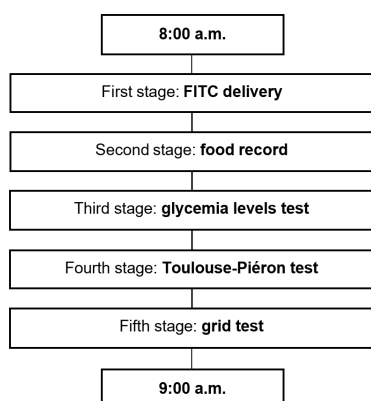
suppress the puncture site with cotton and discard the test strip and lancet in a suitable container.

To identify the concentrated attention levels, we used the Toulouse-Piéron test (Araujo, 2011), which consists of a A4 paper sheet with 40 lines composed of 40 figures (wind rose) with different orientation that should be traced according to 2 models showed on the upper corner of the paper. The total duration of the test is 10 minutes, and it should be taken from top to bottom. The correction of the test consists of subtracting the number of mistakes from the total number of hits. The higher the test score, the higher participant's level of concentrated attention.

The Grid type test verified the distributed attention (Weinberg & Gould, 2017), the tests consists of a grid with 100 numbers (from 00 to 99) distributed randomly. The participant must look for number 00, and start marking the numbers in ascending order. The result of the test is the last number marked by the participant. The higher the test score, the higher the participant's level of distributed attention.

Design and Procedures

This study has a cross-sectional design and quantitative approach to data (Thomas et al., 2012). We visited the research site six times. At our first meeting, we presented the purposes and procedures of the study to the participants, and collected the signatures for the Free and Informed Term of Consent (FITC) and delivered said Terms to be signed by the guardians of the each student. On the other visits, we collected data in the period of June 4 – 17, 2019. The collection occurred always from 8:00 a.m. to 9:00 a.m., right after students arrived at school, following the order of procedures shown on Picture 01.



FITC= Free and Informed Term of Consent. Source: the authors.

Picture 1: Data collection flowchart.

Data Treatment

As we concluded the collection of data, we inserted said data on a Microsoft Excel® spreadsheet, and then exported it to the Statistical Package Social Sciences (SPSS®) program, version 25, for statistical treatment and analysis. The glycemia level and the concentrated and distributed attention levels were systematized as numerical measures, pursuant to the units of measure for each instrument. After the indication of the time of the last meal in the food record, we divided the sample into Fed Group (those who had breakfast) and Fasting Group (those who skipped breakfast) to analyze the attention differences between the groups.

Data Analysis

We used descriptive statistics for sample description with average, standard deviation, minimum and maximum amounts. The normality of data was assessed through the Kolmogorov-Smirnov test. With the independent t-test and the U-Mann-Whitney test we assessed the differences on the glycemia level and the concentrated and distributed attention levels between the Fed and Fasting groups. The Pearson coefficients (concentrated attention) and the Spearman coefficient (distributed attention) allowed us to analyze the correlation between the glycemia level and the concentrated and distributed attention levels. All tests had a significance value of $p < 0.05$.

RESULTS

Table 1 shows the descriptive analysis of age, fasting time, glycemia level and concentrated and distributed attention levels. For the values of fasting time, the sample showed an average slightly lower than 6 hours (5.98 ± 4.91) since their last meal. The glycemia level showed great variation, with a minimum value of 54 mg/dl and a maximum value of 145 mg/dl. Concentrated attention showed the lowest score, a negative value of -11. Distributed attention showed a 25-point interval.

Picture 2 shows the differences in the glycemia levels and concentrated and distributed attention levels between the Fed and Fasting groups. The Fed group showed better glycemia and attention levels, both concentrated and distributed, when compared to the Fasting group. The three variables showed statistically significant differences ($p < 0.05$).

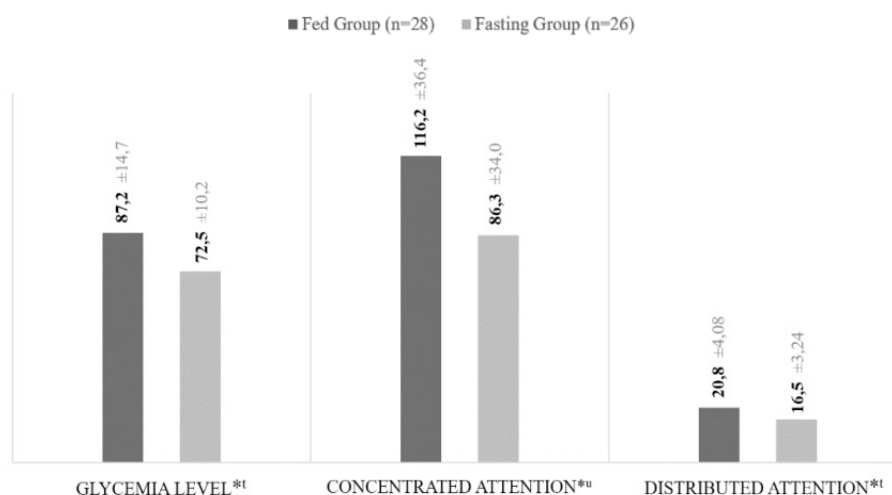


Table 1

Sample description pursuant to age, fasting time, glycemia, concentrated attention and distributed attention (n=54).

Variables	Average	min-max
Age (years)	16,0±0,89	14-17
Fasting time (hours)	5,98±4,91	1-14
Glycemia level (mg/dl)	80,15±14,69	54-145
Concentrated attention (p.)	101,81±38,10	-11-181
Distributed attention (p.)	18,80±4,27	8-33

± = standard deviation; p.= points.

Source: research data.

Table 2 shows the correlation coefficients between the glycemia and concentrated and distributed attention levels. Mild correlations of both types of attention to the glycemia level were observed with statistically significant results for distributed attention ($p < 0.04$).

Table 2

Correlations between distributed attention, concentrated attention and Glycemia levels (n=54).

	GL	r	p
Concentrated attention	101.81=38.10	0.218 ^s	0.13
Distributed attention	18.80=4.27	0.280 ^p	<0.04

GL=glycemia level; r=correlation coefficient; ^sSpearman correlation coefficient; ^pPearson correlation coefficient.

Source: research data.

DISCUSSION

The purpose of this study is to analyze the effects of breakfast consumption and the glycemia levels on concentrated and distributed attention levels on high school students. The main findings indicate that a) the fed participants group showed a higher glycemia level; b) the fed group showed better attention level, both

distributed and concentrated; c) the glycemia level showed mild correlations with both types of attention, with statistically significant results for distributed attention.

The fed group showed higher glycemia level than the fasting group, an expected result, due to the short period of time since the last meal for the first group.

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Barbosa, Roza, Marques & Olegário (2017), in a study developed with the purpose of investigating the lipid profile and glycemia level of children and adolescents of both sexes, with ages of 6 - 19 years old, obtained a result slightly superior to the one found in this study. Both the average results found by Barbosa et al. (2017), and those obtained from the sample of this study are configured as appropriate to health, which are favorable to a better quality of life (Ribeiro et al., 2011).

The fed group showed statistically better results than the fasting group on concentrated and distributed attention levels. In a study performed with 46 participants divided into 2 groups, from 7 to 9 years and from 10 to 15 years old, Correia (2015) found average concentrated attention levels of 94.85 ± 19.12 for the younger group, and 156.77 ± 47.05 for the older group. We observed that the fasting group obtained a lower attention level (86.31 ± 34.01) than both groups assessed by Correia. The fed group showed better (116.21 ± 36.49) concentrated attention levels than Correia's younger group (2015), however, these values were below the results showed by the older group.

Regarding distributed attention, Adriano (2003), when quantifying the concentration ability of 17 indoor soccer athletes, adult and juvenile, after the training sessions, he found average results of 13.41 ± 4.39 , a value below both groups of this study. Under analysis, the collection time (after the training sessions) can justify the low attention levels pointed out by Adriano (2003). The literature emphasizes the positive influence of breakfast in school and physic performance (Deshmukh-Taskar et al., 2010; Höfelmann & Momm, 2014; Hoyland et al., 2009). In this sense, the data of this study suggest that breakfast consumption is associated to better attention levels, both concentrated and distributed, which can explain in part the improvement in school performance.

The glycemia level of the participants showed mild correlations with attention levels, both concentrated and distributed, to the extent that, as the glycemia level increased, the attention levels also increased. The correlation between glycemia level and distributed attention showed statistically significant results, suggesting a positive association between these two variables. Benczik & Casella (2007) highlight attention while a fundamental brain activity for mental assimilation, as the most important condition for the expression of intellect and ability to reflect. The same

way, Benczik et al. (2016) reinforce that attention levels interfere in the learning process, which is directly related to school and sport performance.

In this sense, from the evidence pointed out by the present study that the regular consumption of breakfast is related to increased levels of concentrated and distributive attention and, when considering the important relationship between attention and physical and athletic performance (Domínguez-González, Moral-Campillo, Reigal & Hernández-Mendo, 2018; Reigal, Moral-Campillo, Mier, Morillo-Baro, Morales-Sánchez, Pastrana & Hernández-Mendo, 2020; Reigal, González-Guirval, Baro, Morales-Sánchez, Mier & Hernández-Mendo, 2019; Verburch, Scherder, Van Lange & Oosterlaan, 2014), it is suggested that the promotion of the habit of regular breakfast consumption for young students and athletes is a fundamental aspect.

This study has a number of limitations. A larger sample size could enable other perspectives of data analysis (stratified by sex, for example). Additional data collections throughout the day could expand understanding of differences between study groups. Finally, it would be interesting to use other complementary instruments to assess the participants' attention, offering contrast between the different measures of the same construct. In any case, the present investigation provides data that help to understand the relationship between eating habits and levels of attention in a specific way in relation to two types: concentrated and distributive.

PRACTICAL APPLICATIONS

The purpose of this study is to analyze the effects of breakfast consumption and glycemia levels on concentrated and distributed attention levels of high school students. The expectation a priori was that breakfast consumption and higher glycemia levels would be related to better attention levels. The results indicated that the participants who had breakfast showed better concentrated and distributed attention levels, and also that the glycemia level showed a mild correlation with attention levels, with emphasis to distributed attention. In this context, we confirmed the hypothesis of the study.

In this sense, the results of this study to the extent that they evidence the positive effects of breakfast consumption and adequate glycemia levels on better attention levels, both concentrated and distributed,

reinforce the importance of strategies for promoting good eating habits at school. Awareness campaigns, public policies for school lunch and constant dialog with young people on the importance of breakfast consumption can contribute to a healthy diet, cooperating to the increase of attention levels, and, as a consequence, improve school performance.

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