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# Relationship Between Physical Fitness and Dietary Habits of Early School-age Children

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***Abstract:*** *The aim of this research was to investigate whether individual dietary habits are associated with the physical fitness of early school-age children. In children and adolescents, physical fitness is negatively correlated with cardiorespiratory diseases, high blood pressure, abdominal obesity, overall obesity, skeletal health impairment, hyperinsulinemia, insulin resistance, atherogenic lipid profile, and other metabolic risk factors. Previous research has confirmed the link between low levels of physical fitness in young people and several factors, such as improper dietary habits. Most studies investigating the impact of dietary habits on health have focused on the effect of diet on changes in weight and body composition. Skipping breakfast, snacking, or consuming sugary drinks are associated with higher body mass index (BMI) or waist circumference (WC) in adults and children. The study was conducted on a sample of 940 participants, randomly selected from several primary schools in the Skopje region. The sample was divided into two subsamples by gender, comprising 466 male participants and 474 female participants. The study used 7 criterion variables (fitness tests) and 2 predictor variables. Differences between groups were determined by one-way multivariate and univariate analysis of covariance (MANCOVA and ANCOVA) with partialization by age (age was treated as a fixed covariate). The results of the study showed that boys who reported eating breakfast every day showed better results in aerobic fitness, running 20 meters with progressive speed increase (20m shuttle run test - Stg), and running 20 meters with progressive speed increase (VO2 max), which was not the case for girls. Dietary habits, such as fruit consumption, did not have a statistically significant impact on physical fitness (motor status) in this study.*

***Keywords:*** *children, physical fitness, dietary habits.*

## INTRODUCTION

Monitoring physical fitness is a powerful predictor of health status in childhood, adolescence, and adulthood (Guedes, et al., 2012; Blair, et al. 2001; Williams, 2001; Myers, et al., 2004; Warburton, et al. , 2006; Ortega et al., 2008). Even in children and adolescents, physical fitness is negatively correlated with cardiorespiratory diseases, high blood pressure (Ruiz, et al., 2006), abdominal obesity (Brunet, et al. 2007), overall obesity (Ruiz, et al., 2006; Ortega, et al., 2007.), skeletal health impairment (Moliner-Urdiales, et al., 2010.), hyperinsulinemia (Gutin, et al., 2004.), insulin resistance (Gulati, et al., 2003.), atherogenic lipid profile (Mesa, et al., 2006), and other metabolic risk factors (Rizzo, et al., 2007). Previous research has confirmed the link between low levels of physical fitness in young people and several factors such as genetic, biological, familial, environmental, behavioral, gender, low income, improper diet, inadequate levels of physical activity, sedentary habits, and excess body fat (Ortega, et al., 2008; Hainer, et al., 2009; de Andrade, et al., 2015; de Andrade, et al., 2016). Several dietary habits have been associated with early progression of overweight and obesity (Isacco et al., 2011., Moreno and Rodriguez, 2007., Mota et. al., 2008.). Most studies investigating the impact of dietary habits on health have focused on the effect of diet on changes in weight and body composition. Skipping breakfast, snacking, or consuming sugary drinks are associated with higher body mass index (BMI) or waist circumference (WC) in adults (Duvigneaud et al., 2007., Holmback et al., 2010.) and children (Isacco et al., 2011, Moreno and Rodriguez, 2007 ,Motaetal., 2008). Furthermore, it has been shown that objectively measured levels of habitual physical activity correlate with cardiorespiratory fitness (CRF) assessed by direct measurement of VO2max in children (Dencker et al., 2006, Ekelund et al., 2001), which is considered a marker of health status (Hurtig-Wennlof, A., Ruiz, J. R., Harro, M., & Sjostrom,M. 2007)). To date, a limited number of studies have investigated the relationship between dietary habits and CRF in children. Although risk factor analysis is now a new challenge in many research fields, including health promotion, sociodemographics, kinesiology, and behavioral sci-

ences (Guedes, et al., 2012; Condello, et al., 2016), very few studies have explored the association between physical fitness and risk factors (Grao-Cruces, et al., 2014; Castro-Piñero, et al., 2012).

## MATERIALS AND METHODS

### *Participants*

The study was conducted on a sample of 940 participants, randomly selected from several primary schools in the Skopje region. The sample was divided into two subsamples by gender, comprising 466 male participants and 474 female participants. The sample included all students for whom parental consent was obtained to participate in the project and who were psychophysically healthy and regularly attended physical and health education classes.

### *Variables*

*Sampled* The study used 7 criterion variables (fitness tests) and 2 predictor variables.

**Criterion variables** for flexibility, musculoskeletal fitness, motor fitness, and cardiorespiratory fitness: sit-and-reach (FLE), handgrip dynamometry (HG), standing long jump (SLJ), sit-ups in 30 seconds (SIT30), 4 x 10-meter shuttle run test (4X10M), 20-meter shuttle run test with progressive speed increase (Stg), maximal oxygen uptake during a progressive 20-meter run (VO2 max).

**Predictor variables**: Frequency of breakfast consumption during school days, Weekly frequency of fruit consumption.

### *Methodology*

For all variables measured on interval or ratio scales, the following basic statistical parameters were calculated: mean (X), standard deviation (SD). Differences between groups were determined by one-way multivariate and univariate analysis of covariance (MANCOVA and ANCOVA) with age partialization (age was treated as a fixed covariate).

## RESULTS

***Table 1.*** *Differences in Motor Status Between Groups of Male Participants Based on Frequency of Breakfast Consumption During School Days*

| | Value | F | Hypothesis df | Error df | Sig. | $n^2$ |
|---|---|---|---|---|---|---|
| Wilks' lambda | 0.99 | 0.86 | 7 | 455 | .538 | .013 |

| | Don't have breakfast every day | | Have breakfast every day | | F | Sig. | $n^2$ |
|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | | |
| FLE | 14.54 | 6.80 | 14.55 | 6.16 | 0.01 | .937 | .000 |
| HG | 13.86 | 3.82 | 14.01 | 4.65 | 0.06 | .803 | .000 |
| SLJ | 113.34 | 23.45 | 117.37 | 24.45 | 3.22 | .073 | .007 |
| SIT 30 | 13.11 | 5.40 | 13.89 | 5.33 | 2.47 | .117 | .005 |
| 4x10m | 14.83 | 2.27 | 14.50 | 2.00 | 2.91 | .089 | .006 |
| Stg | 3.63 | 1.55 | 3.94 | 1.59 | 4.19 | **.041** | .009 |
| VO2max | 48.56 | 3.67 | 49.21 | 3.52 | 4.40 | **.037** | .009 |

In Table 1, the results of multivariate analysis of covariance between groups of male participants based on whether there is a computer in their child's room are shown. From the obtained results, according to Wilks' Lambda Rao's F-approximation, which is 0.86, and the level of statistical significance Sig .538, it is evident that there are no statistically significant differences between groups. From the results of univariate analysis of covariance with age

partialization, it can be determined that statistically significant differences were obtained in 2 variables: maximal oxygen uptake (VO2max) at the level of p=.037, and for the variable shuttle run 20 meters with progressive increase in speed (distance covered) (Stg) at the level of p=.041.

From the multivariate analysis of covariance (Table 2), with Rao's F-approximation of 1.83, and a significance level of Sig .079, it is visible that there are no statistically significant differences between groups. Furthermore, from the analysis of univariate analysis of covariance with age partialization and from the obtained results, it can be said that there are no statistically significant differences in any of the seven variables among the participants formed based on how often they eat breakfast during school days.

***Table 2.*** *Differences in Motor Status Between Groups of Female Participants Based on Breakfast Consumption Frequency During School Days*

| | Don't have breakfast every day | | Have breakfast every day | | F | Sig. | $n^2$ |
|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | | |
| FLE | 16.77 | 6.16 | 17.74 | 6.79 | 2.57 | .110 | .005 |
| HG | 12.56 | 4.94 | 12.80 | 4.09 | 0.20 | .658 | .000 |
| SLJ | 106.26 | 23.36 | 103.65 | 20.89 | 1.84 | .175 | .004 |
| SIT 30 | 11.53 | 5.42 | 12.27 | 4.77 | 2.01 | .157 | .004 |
| 4x10M | 15.49 | 2.00 | 15.52 | 2.06 | 0.11 | .739 | .000 |
| Stg | 3.17 | 1.14 | 3.10 | 1.13 | 0.59 | .443 | .001 |
| VO2max | 47.62 | 2.96 | 47.27 | 3.14 | 0.90 | .343 | .002 |

| | Value | F | Hypothesis df | Error df | p. | $n^2$ |
|---|---|---|---|---|---|---|
| Wilks' lambda | 0.97 | 1.83 | 7 | 459 | .079 | .027 |

In Table 3, differences in motor status between groups of male participants based on their weekly frequency of fruit consumption are shown. From the multivariate analysis of covariance with Rao's F-approximation of 0.34, and a significance level of Sig .935, it is evident that there are no statistically significant differences between groups. Furthermore, from the univariate analysis of covariance with age partialization and the obtained results, it can be observed that there are no statistically significant differences.

***Table 3.*** *Differences in Motor Status Between Groups of Male Participants Based on Weekly Frequency of Fruit Consumption*

| | Value | F | Hypothesis df | Error df | p. | $n^2$ |
|---|---|---|---|---|---|---|
| Wilks' lambda | 1.00 | 0.34 | 7 | 455 | .935 | .005 |

| | Less than once a day | | Once a day or more | | F | Sig. | $n^2$ |
|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | | |
| FLE | 14.77 | 6.57 | 14.28 | 6.19 | 0.52 | .470 | .001 |
| HG | 13.77 | 3.81 | 14.17 | 4.92 | 0.74 | .389 | .002 |
| SLJ | 115.85 | 24.23 | 115.92 | 24.08 | 0.04 | .847 | .000 |
| SIT 30 | 13.48 | 5.30 | 13.76 | 5.45 | 0.14 | .706 | .000 |
| 4x10M | 14.69 | 2.03 | 14.54 | 2.20 | 0.35 | .554 | .001 |
| Stg | 3.83 | 1.60 | 3.82 | 1.56 | 0.07 | .787 | .000 |
| VO2max | 49.03 | 3.70 | 48.91 | 3.46 | 0.04 | .841 | .000 |

According to Wilks' Lambda, Rao's F-approximation (Table 4) which is 1.06, and the significance level Sig .387, it can be said that there are no statistically significant differences between groups of participants at the multivariate level. Furthermore, from the analysis of univariate analysis of covariance with age partialization among female participants based on their weekly frequency of fruit consumption, it can be stated that no statistically significant differences were found.

***Table 4.*** *Differences in Motor Status Between Groups of Female Participants Based on Weekly Frequency of Fruit Consumption*

| | Less than once a day | | Once a day or more | | F | Sig. | $n^2$ |
|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | | |
| FLE | 17.53 | 6.78 | 17.21 | 6.36 | 0.36 | .549 | .001 |
| HG | 13.09 | 5.17 | 12.36 | 3.63 | 2.35 | .126 | .005 |
| SLJ | 104.43 | 21.94 | 104.91 | 21.92 | 0.18 | .670 | .000 |
| SIT 30 | 12.01 | 5.20 | 11.95 | 4.91 | 0.02 | .885 | .000 |
| 4x10M | 15.51 | 2.13 | 15.51 | 1.95 | 0.09 | .766 | .000 |
| Stg | 3.15 | 1.15 | 3.10 | 1.12 | 0.14 | .713 | .000 |
| VO2max | 47.16 | 3.03 | 47.63 | 3.10 | 1.10 | .296 | .002 |

| | Value | F | Hypothesis df | Error df | p. | $n^2$ |
|---|---|---|---|---|---|---|
| Wilks' lambda | 0.98 | 1.06 | 7 | 459 | .387 | .016 |

## DISCUSSION

Daily breakfast can be considered a healthy eating habit. Indeed, daily reported breakfast consumption has been associated with healthier BMI, lipid profiles, and greater physical activity among European children (Papoutsou et al., 2014). However, skipping breakfast was not associated with lower physical activity, poorer physical fitness, or more sedentary time among European adolescents (Cuenca-Garc´ıa et al., 2014), and similar results were found among British adolescents (Corder et al., 2011). The findings of this study show that boys who reported eating breakfast daily had better results in aerobic fitness, which was not the case for girls.

Cardiorespiratory fitness assessed during shuttle run tests has been found to be associated with healthy eating habits in children (Sandercock et al., 2010). Similarly, healthy eating habits have recently been linked to overall fitness in children (mile run, squats, push-ups, height, and weight) (Edwards, Mauch, & Winkelman, 2011). Longitudinal analyses have revealed a positive association between reported breakfast consumption and aerobic fitness. This shows that the effect may vary depending on the type of physical fitness. Insufficient data on the quality of reported breakfast consumption limit the discussion of these results.

Dietary habits (fruit consumption) did not have a statistically significant impact on physical fitness in this study. This is not in line with the awareness that nutrition is an important part of athletic performance, especially in childhood and adolescence, as it enables optimal growth and development (Purcell et al., 2013). Further studies are needed to deeply explore the relationship between food consumption habits and physical fitness.

## CONCLUSION

The aim of this study was to investigate whether individual dietary habits are associated with the physical fitness of early school-age children. Boys who reported eating breakfast daily showed better results in aerobic fitness, as indicated by the 20-meter shuttle run test with progressive speed increase (Stg) and the progressive speed increase in the 20-meter run (VO2max), which was not the case for girls. Dietary habits, such as fruit consumption, did not have a statistically significant impact on physical fitness test results (motor status) in male and female participants in this study.

## REFERENCES

Blair, S. N., Cheng, Y., & Holder, J. S. (2001). Is physical activity or physical fitness more important in defining health benefits?. *Medicine & Science in Sports & Exercise*, *33*(6), S379-S399.

Brunet, M., Chaput, J. P., & Tremblay, A. (2007). The association between low physical fitness and high body mass index or waist circumference is increasing with age in children: the 'Quebec en Forme'Project. *International journal of obesity*, *31*(4), 637-643.

Castro-Piñero, J., Padilla-Moledo, C., Ortega, F. B., Moliner-Urdiales, D., Keating, X., & Ruiz, J. R. (2012). Cardiorespiratory fitness and fatness are associated with health complaints and health risk behaviors in youth. *Journal of Physical Activity and Health*, *9*(5), 642-649.

Condello, G., Ling, F. C. M., Bianco, A., Chastin, S., Cardon, G., Ciarapica, D., ... & DEDIPAC consortium. (2016). Using concept mapping in the development of the EU-PAD framework (European-Physical Activity Determinants across the life course): a DEDIPAC-study. *BMC public health*, *16*, 1-16.

Corder, K., Van Sluijs, E. M. F., Steele, R. M., Stephen, A. M., Dunn, V., Bamber, D., ... & Ekelund, U. (2011). Breakfast consumption and physical activity in British adolescents. *British Journal of Nutrition*, *105*(2), 316-321.

Cuenca-Garcia, M., Ruiz, J. R., Ortega, F. B., Labayen, I., González-Gross, M., Moreno, L. A., ... & Castillo, M. J. (2014). Association of breakfast consumption with objectively measured and self-reported physical activity, sedentary time and physical fitness in European adolescents: the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) Study. *Public health nutrition*, *17*(10), 2226-2236.

Thivel, D., Isacco, L., Lazaar, N., Aucouturier, J., Ratel, S., Doré, E., ... & Duché, P. (2011). Effect of a 6-month school-based physical activity program on body composition and physical fitness in lean and obese schoolchildren. *European journal of pediatrics*, *170*, 1435-1443.

Gonçalves, E. C. D. A., & Silva, D. A. S. (2016). Factors associated with low levels of aerobic fitness among adolescents. *Revista Paulista de Pediatria*, *34*(2), 141-147.

*Edwards, J. U., Mauch, L., & Winkelman, M. R. (2011). Relationship of nutrition and physical activity behaviors and fitness measures to academic performance for sixth graders in a midwest city school district. Journal of School Health, 81(2), 65-73.*

Condello, G., Ling, F. C. M., Bianco, A., Chastin, S., Cardon, G., & Ciarapica, D. & Gjaka, M.(2016). Using concept mapping in the development of the EU-PAD framework (EUropean-Physical Activity Determinants across the life course): a DEDIPAC-study. *BMC public health*, *16*(1), 1145.

Grao-Cruces, A., Fernández-Martínez, A., & Nuviala, A. (2014). Association of fitness with life satisfaction, health risk behaviors, and adherence to the Mediterranean diet in Spanish adolescents. *The Journal of Strength & Conditioning Research*, *28*(8), 2164-2172.

Guedes, D. P., Neto, J. M., Lopes, V. P., & Silva, A. J. (2012). Health-related physical fitness is associated with selected sociodemographic and behavioral factors in Brazilian school children. *Journal of Physical Activity and Health*, *9*(4), 473-480.

Gulati, M., Pandey, D. K., Arnsdorf, M. F., Lauderdale, D. S., Thisted, R. A., Wicklund, R. H., ... & Black, H. R. (2003). Exercise capacity and the risk of death in women: the St James Women Take Heart Project. *Circulation*, *108*(13), 1554-1559.

Gutin, B., Yin, Z., Humphries, M. C., Hoffman, W. H., Gower, B., & Barbeau, P. (2004). Relations of fatness and fitness to fasting insulin in black and white adolescents. *The Journal of pediatrics*, *145*(6), 737-743.

Hainer, V., Toplak, H., & Stich, V. (2009). Fat or fit: what is more important?. *Diabetes care*, *32*(suppl 2), S392-S397.

Hurtig-Wennlof, A., Ruiz, J. R., Harro, M., & Sjostrom, M. (2007). Cardiorespiratory Fitness Relates More Strongly than Physical Activity to Cardiovascular Disease Risk Factors in Healthy Children and Adolescents: The European Youth Heart Study. European Journal of Preventive Cardiology, 14, 575-581. https://doi.org/10.1097/HJR.0b013e32808c67e3

Holmbäck, I., Ericson, U., Gullberg, B., & Wirfält, E. (2010). A high eating frequency is associated with an overall healthy lifestyle in middle-aged men and women and reduced likelihood of general and central obesity in men. *British journal of nutrition*, *104*(7), 1065-1073.

Dencker, M., Thorsson, O., Karlsson, M. K., Lindén, C., Svensson, J., Wollmer, P., & Andersen, L. B. (2006). Daily physical activity and its relation to aerobic fitness in children aged 8–11 years. *European journal of applied physiology*, *96*, 587-592.

Mesa, J. L., Ruiz, J. R., Ortega, F. B., Wärnberg, J., González-Lamuño, D., Moreno, L. A., ... & Castillo, M. J. (2006). Aerobic physical fitness in relation to blood lipids and fasting glycaemia in adolescents: influence of weight status. *Nutrition, metabolism and cardiovascular diseases*, *16*(4), 285-293.

Moreno, L. A., & Rodriguez, G. (2007). Dietary risk factors for development of childhood obesity. *Current Opinion in Clinical Nutrition & Metabolic Care*, *10*(3), 336-341.

Myers, J., Kaykha, A., George, S., Abella, J., Zaheer, N., Lear, S., ... & Froelicher, V. (2004). Fitness versus physical activity patterns in predicting mortality in men. *The American journal of medicine*, *117*(12), 912-918.

Duvigneaud, N., Wijndaele, K., Matton, L., Philippaerts, R., Lefevre, J., Thomis, M., ... & Duquet, W. (2007). Dietary factors associated with obesity indicators and level of sports participation in Flemish adults: a cross-sectional study. *Nutrition Journal*, *6*, 1-12.

Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjöström, M. (2008). Physical fitness in childhood and adolescence: a powerful marker of health. *International journal of obesity*, *32*(1), 1-11.

Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjöström, M. (2008). Physical fitness in childhood and adolescence: a powerful marker of health. *International journal of obesity*, *32*(1), 1-11.

Ortega, F. B., Tresaco, B., Ruiz, J. R., Moreno, L. A., Martin-Matillas, M., Mesa, J. L., ... & Castillo, M. J. (2007). Cardiorespiratory fitness and sedentary activities are associated with adiposity in adolescents. *Obesity*, *15*(6), 1589-1599.

Papoutsou, S., Briassoulis, G., Wolters, M., Peplies, J., Iacoviello, L., Eiben, G., ... & Tornaritis, M. (2014). No breakfast at home: association with cardiovascular disease risk factors in childhood. *European journal of clinical nutrition*, *68*(7), 829-834.

Purcell, L. K., Canadian Paediatric Society, & Paediatric Sports and Exercise Medicine Section. (2013). Sport nutrition for young athletes. *Paediatrics & child health*, *18*(4), 200202.

Mota, J., Fidalgo, F., Silva, R., Ribeiro, J. C., Santos, R., Carvalho, J., & Santos, M. P. (2008). Relationships between physical activity, obesity and meal frequency in adolescents. *Annals of human biology*, *35*(1), 1-10.

Rizzo, N. S., Ruiz, J. R., Hurtig-Wennlöf, A., Ortega, F. B., & Sjöström, M. (2007). Relationship of physical activity, fitness, and fatness with clustered metabolic risk in children and adolescents: the European youth heart study. *The Journal of pediatrics*, *150*(4), 388-394.

Ruiz, J. R., Rizzo, N. S., Hurtig-Wennlöf, A., Ortega, F. B., W àrnberg, J., & Sjöström, M. (2006). Relations of total physical activity and intensity to fitness and fatness in children: the European Youth Heart Study–. *The American journal of clinical nutrition*, *84*(2), 299303.

Sandercock, G. R. H., Voss, C., and Dye, L. (2010). Associations between habitual school-day breakfast consumption, body mass index, physical activity and cardiorespiratory fitness in English schoolchildren. Eur. J. Clin. Nutr. 64, 1086–1092. doi: 10.1038/ejcn.2010.145

U. Ekelund *et al.* (2001) Physical activity in relation to aerobic fitness and body fat in 14- to 15-year-old boys and girlsEuropean Journal of Applied Physiology (2001)Volume 170, pages 1435–1443, (2011) European Journal of Pediatrics

Warburton, D. E., Nicol, C. W., & Bredin, S. S. (2006). Health benefits of physical activity: the evidence. *Cmaj*, *174*(6), 801-809.

Williams, P. T. (2001). Physical fitness and activity as separate heart disease risk factors: a meta-analysis. *Medicine and science in sports and exercise*, *33*(5), 754.

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