Original research

Familial resemblance of physical activity levels in the Portuguese population

José Maia [a,*], Thayse N. Gomes [a], David-Alexandre Trégouët [b], Peter T. Katzmarzyk [c]

[a] CIFI²D, Kinanthropometry Lab, Faculty of Sport, University of Porto, Portugal
[b] INSERM, UMR_S 937, ICAN Institute for Cardiometabolism and Nutrition, Pierre and Marie Curie University (UPMC, Paris 6), France
[c] Pennington Biomedical Research Center, Louisiana State University System, USA

ARTICLE INFO

ABSTRACT

Objectives: Moderate to high levels of physical activity are related to positive health status. Parents share with their children important cultural aspects and beliefs related to healthy living. However, family studies show contradictory results for familial aggregation of physical activity. The purposes of this study were to assess whether physical activity shows familial aggregation in the Portuguese population and to disentangle the exact pattern of familial resemblance.

Design: Cross-sectional family study.

Methods: We sampled 2661 Portuguese nuclear families (10,644 subjects) and assessed their physical activity using the Baecke questionnaire, including components for physical activity work/school, leisure-time activity, sports participation, and a total index of physical activity. Generalized estimating equations were used to compute spousal, parent–offspring and sibling correlations.

Results: For leisure-time activity and total index of physical activity, the patterns were characterized with spouse correlations higher than parent–offspring correlations (0.20 vs 0.12, $p = 0.001$ and 0.22 vs 0.12, $p = 10^{-4}$, respectively) but lower than those in offspring (0.20 vs 0.51, $p < 10^{-4}$ and 0.22 vs 0.35, $p < 10^{-4}$, respectively). For sports participation, the spouse correlation was higher than parent–offspring correlations (0.30 vs 0.18, $p < 10^{-4}$), but also higher than sibling correlations (0.30 vs 0.22, $p < 10^{-4}$). Finally, the physical activity work/school spouse correlation was higher than the sibling correlations (0.22 vs 0.12, $p < 10^{-4}$).

Conclusions: The results support the hypothesis of familial aggregation in physical activity. Further, fathers and mothers had a similar influence on their offspring's physical activity levels irrespective of their sex, and equal sibling correlations point toward shared physical activity habits.

© 2013 Sports Medicine Australia. Published by Elsevier Ltd. All rights reserved.

1. Introduction

There is a strong belief, based on consistent lines of research, that moderate to high levels of physical activity (PA) and/or exercise participation are related to a better health status, morbidity reduction and increases in longevity.[1] Furthermore, such healthy behaviors have consistently been shown to generate transitional benefits from childhood through adolescence into adulthood.[2]

Important behaviors are built, developed and expressed within the familial nucleus where parents transmit and share with their children important cultural aspects and beliefs related to the body, and its care, as well as ways to link them to active lifestyles and healthy living. The study of variation of PA levels and patterns within and between family members is then of great importance because we may be able not only to disentangle the complex ways in which PA levels (from sedentary to moderate to vigorous) tend to aggregate, or not, within the family nucleus, but also with this information we may expose them to more adequate and precise PA/physical exercise intervention programs taking the family, and the differences among its members, into consideration. Family resemblance as discussed in this paper is the relationship between parental and child activity levels. Three literature reviews concerning parental influences/correlates of PA in youth[3–5] generally support these notions, although there is evidence for a discrepancy between the observed patterns of family resemblance. For example, Adkins et al. (2004)[6] using USA family data reported a correlation between parents and siblings' PA of 0.45, whereas Jacobi et al.[7] using French family data showed no significant correlations for the father–offspring dyads. Furthermore, a significant positive role of birth-order effects were noticed in Iceland[8] and Estonia siblings PA[9] with correlations ranging from 0.06 to 0.35, whereas Wu

* Corresponding author.
  E-mail address: jmaia@fade.up.pt (J. Maia).

and Pender (2002)[10] found no significant birth-order effects in Taiwanese siblings PA levels. These mixed and/or inconclusive results may be due to different nuclear family sampling, family structure and size, instruments used to estimate PA and derived components, complexity and diversity of research questions and interactions with other variables such as socioeconomic status, ethnicity, social learning, parental role modeling and support.

The search for specific patterns in family correlations helps in the understanding of how parents share their PA levels with their children, and how siblings share their PA behaviors (for a review see Vilhena e Santos et al.[11]). One line of research computes familial correlations to describe similarity/dissimilarity among family members, namely parent–child resemblance in PA and exercise habits without positing any specific hypothesis regarding vertical (from parents to offspring) transmission, and/or horizontal (among siblings) sharing in what concerns the magnitude of correlations.[7,12–14] Another line of study usually tests for different correlation patterns among family members. For example, Simonen et al.[15] tested nine possible models with different correlation patterns among nuclear family members. The main purpose of this approach is to identify the most parsimonious correlational model that allows the computation of the best estimate of the relative influence of genetic factors on PA and/or exercise behaviors.[15]

This study was aimed at assessing the existence of familial correlations for different PA components and at characterizing the pattern of resemblance among Portuguese nuclear families. In particular, we were interested in testing whether PA family correlations could be of similar magnitude among all classes of relatives which would suggest a shared "environmental" component or whether these correlations demonstrated sex- and generational-specific influences.

2. Methods

The sample included 2661 Portuguese nuclear families (i.e., father, mother, and two siblings) with a total of 10,644 subjects. Data were collected between 2006 and 2008 as a part of the Famílias Portuguesas Saudáveis project (Healthy Portuguese Families Project) which investigates physical growth, body composition, PA, physical fitness, nutritional and health behaviors, built environment, and metabolic syndrome. In phase one of this project PA was assessed in the northern and central mainland municipalities of the country. Very briefly, a sample of 25 public and 5 private schools, evenly distributed among the selected regions was randomly selected from the available schools. The response rate was ~20%. Children and adolescents were recruited in schools through project advertisement and were approached to voluntarily participate in the study with their siblings and parents. Given that families with 3 or more children are scarce in the Portuguese population,[16] our sample included nuclear families with only two children. From a phenotype measured in two parents and two siblings, up to eight family correlations can be computed (see below). Children with chronic diseases, physical handicaps or psychological disorders were excluded as these conditions might impair their daily routines namely their physical activities within schools and/or sports clubs. The ethics committee of the Faculty of Sport, University of Porto, and the respective school authorities approved the project. Written informed consent was obtained from all subjects.

The Baecke questionnaire[17] was used to estimate past year involvement in PA. It has been consistently shown as a reliable and valid instrument to describe different dimensions of PA. The Baecke questionnaire has been validated against accelerometer measures of PA energy expenditure,[18] doubly labeled water measures of total energy expenditure,[19] and other PA questionnaires.[20] Furthermore

it has been used in Portuguese children and adolescents from 10 years onwards,[21,22] and has high reliability estimates in subjects of this age range.[23,24]

The Baecke questionnaire includes a total of 16 questions mapping three PA domains: work/school, sports, and leisure-time. Each domain consists of questions scored on a five-point Likert scale with higher scores indicating higher PA levels. Work/school domain (PAWS) incorporates questions related to occupation, sitting, standing, walking, lifting and sweating during work/school; the sports domain (SPO) incorporates questions related to type of sport, frequency of practice, and sweating during sport practice; and the leisure-time activities (LTA) domain includes questions related to mode of transportation to work/school, and time spent watching TV, walking and cycling. For each domain, one index is computed, and the sum of these three indices is defined as the total PA index (TPAI). Scores for the three indices can vary from 1 to 5, and the TPAI has a range from 3 to 15.

All children and adolescents answered the questionnaire during their physical education (PE) classes under their teachers' supervision, which were previously trained by the project staff members to ensure that all items were properly understood. All children and adolescents took the questionnaires to their parents, which were completed at their homes. Furthermore, all research team members were available to answer queries from parents if they needed further assistance at their home or through a telephone interview.

Height and weight were measured to the nearest 1.0 mm and 0.1 kg, respectively, in all children according to the procedures of Lohman et al.[25] using a Siber Hegner stadiometer and a Seca digital scale (model 770). Parents self-reported their height and weight in a mailed questionnaire. BMI was calculated [weight (kg)/height (m)^2], and was used to classify subjects as normal weight, overweight or obese according to the cut-points of the World Health Organization[26] (for adults) and Cole et al.[27] (for children).

Socioeconomic status (SES) was estimated based on parental occupations. The occupation was categorized into nine groups (from 1 to 9) according to the Portuguese National Classification of Occupations,[28] where group 1 is the highest SES and group 9 is the lowest. No information was gathered about annual income, but it is closely related to the classification system. The groups are categorized as follows: 1: central administration/politicians and executive directors; 2: specialists of intellectual and scientific activities; 3: technicians and intermediate level jobs; 4: back-office jobs; 5: security, seller and individual services; 6: farmer and qualified workers of farm, fish and forest; 7: industry and building qualified jobs: 8: machine and equipment operators; 9: non-qualified jobs. Information about sex and age of the parents was obtained when they were asked about their jobs.

Exploratory data analysis for outlier detection, normality distribution checks and descriptive statistics were done in SPSS 20.0. In order to handle the non-independence among family observations, all regression and correlation analyses were conducted within the framework of generalized estimating equations (GEEs), an elegant and efficient alternative to Maximum Likelihood methods that does not require any distributional assumption. GEEs are highly flexible for studying covariate effects on means and correlations, and are asymptotically robust to a misspecification of the exact patterns of correlations between observations and of correlations between correlations. GEEs are in particular well-suited to family data analysis where observations between relatives may be correlated due to shared environment and genetic factors.[29] For the current application, we used the GESEE software developed by Tregouet et al.,[30] as previously applied by Plancoulaine et al.,[31,32] and adopted the Gaussian working correlation matrix which corresponds to the covariance matrix of a multivariate normal distribution.[29] For the regression mean model, analyses were adjusted for age, age,[2] sex,