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Incidence of high blood pressure in children — Effects of physical activity and sedentary behaviors: The IDEFICS study
High blood pressure, lifestyle and children

Augusto César Ferreira de Moraes [a,b,c,*], Heráclito Barbosa Carvalho [a,c], Alfonso Siani [d], Gianvincenzo Barba [d,1], Toomas Veidebaum [e], Michael Tornaritis [f], Denes Molnar [g], Wolfgang Ahrens [h], Norman Wirsik [h], Stefaan De Henauw [i], Staffan Mårild [j], Lauren Lissner [k], Kenn Konstabel [e], Yannis Pitsiladis [l], Luis A. Moreno [b,m], on behalf of the IDEFICS consortium

[a] School of Medicine of the University of São Paulo, FMUSP, São Paulo, Brazil
[b] Universidad de Zaragoza, Facultad de Ciencias de la Salud, GENUD Research Group (Growth, Exercise, Nutrition and Development) Zaragoza, Spain
[c] YCARE (Youth/Child and Cardiovascular Risk and Environmental) Research Group, FMUSP, Brazil
[d] Unit of Epidemiology and Population Genetics, Institute of Food Sciences, National Research Council, Avellino, Italy
[e] Department of Chronic Diseases, National Institute for Health Development, Tallinn, Estonia
[f] Research and Education Foundation of Child Health, Strovolos, Cyprus
[g] Department of Paediatrics, Medical Faculty, University of Pécs, Pécs, Hungary
[h] Leibniz Institute for Prevention Research and Epidemiology - BIPS, Bremen, Germany
[i] Department of Public Health, Ghent University, Ghent, Belgium
[j] Department of Paediatrics, University of Gothenburg, Gothenburg, Sweden
[k] Department of Public Health and Community Medicine, University of Gothenburg, Sweden
[l] University of Glasgow, Faculty of Biomedical and Life Sciences, Glasgow, Scotland, United Kingdom
[m] School of Medicine of the University of São Paulo, Department of Preventive Medicine, São Paulo, Brazil

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ABSTRACT

Background/objectives: High blood pressure (HBP) is one of the most important risk factors for cardiovascular diseases and it has a high prevalence in pediatric populations. However, the determinants of the incidence of Pre-HBP and HBP in children are not well known. i) To describe the incidence of HBP in European children; and ii) to evaluate the effect of physical activity (PA) and sedentary behavior (SB) on the Pre-HBP and HBP.

Methods: The IDEFICS cohort study. A total of 16,228 children 2–9 years at baseline were recruited by complex sampling population-based survey in eight European countries. At baseline (T0), 5221 children were selected for accelerometer measurements; 5061 children were re-examined 2 years later (T1). We estimated the incidence of Pre-HBP and HBP and evaluate the effect of PA and SB on the Pre-HBP and HBP, by computing relative risks and the corresponding 95% confidence intervals (RR, 95% CI).

Results: Incidences of Pre-HBP and HBP per year were: 121/1000 children and 110/1000 children, respectively. We found that children maintaining SB > 2 h/d during the two year follow-up showed a RR of having HBP of 1.28 (1.03–1.60). Children in T1 not performing the recommended amount of PA (<60 min/d) have a RR of HBP of 1.53 (1.12 to 2.09). We found no association between pre-HBP and the behaviors.

Conclusion: The incidence of pre-HBP and HBP is high in European children. Maintaining sedentary behaviors during childhood increases the risk of developing HBP after two years of follow-up.

1. Introduction

Chronic non-communicable diseases are the main source of disease burden worldwide and are thus a major public health problem [1]. Among non-communicable diseases, hypertension has been shown to have the highest prevalence in adults [2], and studies have shown that blood pressure (BP) levels in childhood and adolescence greatly impact the development of hypertension in adulthood [3].

Among the factors that may influence blood pressure levels (e.g. genetics, intrauterine development, socioeconomic status, tobacco use, total and abdominal obesity), physical activity (PA) and sedentary behaviors (SB) have been shown inverse [4] and direct associations [5,6], respectively, with blood pressure in children.

* Corresponding author at: Faculdade de Medicina da USP, Departamento de Medicina Preventiva, 2° andar, sala 2162, Secretaria de Pós-Graduação, Av. Dr. Arnaldo, 455, Cerqueira César, CEP: 01246-903 São Paulo, Brazil.
E-mail address: augustocesar.demoraes@usp.br (A.C.F. de Moraes).
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Although the effects of PA and SB on BP have mainly been examined in isolation, there are studies suggesting that these behaviors have an aggregate effect in children [7]; however, few studies have quantified the association between combined PA/SB levels and cardiovascular risk in children, like blood pressure. On the other hand, PA/SB levels are associated with sociodemographic and economic variables. The influence of sociodemographic factors on PA/SB has been described in a review [8]. There is no consensus in the literature regarding socioeconomic variables as determinants of these behaviors since such differences may be attributed to the demographic context and characteristics of the populations studied rather than the individual [9,10].

Reproducing the same results in different population groups with different characteristics would increase their biological plausibility and provide a higher level of scientific evidence. For this reason, we have included results from a multi-national European study in this report. We tested our hypothesis, in cohort studies conducted with children within the IDEFICS study *(**I**dentification and prevention of **D**ietary- and lifestyle-induced health **EF**fects **I**n **C**hildren and infant**S**)*.

Thus, we hypothesized that low levels of PA and high levels of SB may contribute to the development of high blood pressure (HBP).

2. Methods

2.1. Study population

The IDEFICS study (***I**dentification and prevention of **D**ietary- and lifestyle-induced health **EF**fects **I**n **C**hildren and infant**S***) is an epidemiological multicenter European study, aiming to identify nutritional and lifestyle-associated etiological factors of childhood obesity and related morbidities. A cohort of 16,228 children aged 2–9 years at baseline (51% of eligible sample), recruited from eight European countries (Germany, Hungary, Italy, Cyprus, Spain, Estonia, Sweden and Belgium), was examined in the baseline survey (T0) and it was the starting point of the prospective study with the largest European children's cohort established to date. They were assessed between September 2007 and May 2008 according to a standardized protocol. Details of the procedures of the IDEFICS project have been previously published [11,12]. These children were followed up longitudinally to assess their development and to determine the etiological associations between baseline predictors and selected follow-up end points by a follow-up survey 2 years later at T1 (September 2009 to May 2010).

As accelerometry was measured only in a random subset of children from every center (due to availability of accelerometers), when the objective measurement of physical activity (PA) was included in the analyses, the sample size was reduced. The present analysis was performed in 5221 children (32.2% of the sample; boys = 51%; age = 6.1 ± 1.8 years; mean ± s.d.) at T0, with a complete set of data including: systolic blood pressure (SBP), diastolic blood pressure (DBP), height, exposures [PA intensities, sedentary behavior (SB)] and confounding variables (Fig. 1). Parents or legal guardians provided written informed consent to participate in the full program or in a selected set of examination modules. For each survey center, the approval of the local Ethical Committee was obtained.

2.2. Outcomes

Data collection procedures were described previously [13]. An arm BP oscilometric monitor device WelchAllyn 42008™, previously validated in this age group was used [14]. It was previously tested for reliability and reproducibility in the IDEFICS project [13]. Two BP readings were taken after 10-min rest, with a 5-min interval between them, and the lowest reading was recorded. The inter-observer coefficients of variation were below 5% for both BP levels.

The outcomes for this study are: Pre-HBP and HBP [15]. Pre-HBP was defined as SBP or DBP between 90th to 95th percentile for age and height; and HBP defined as SBP or DBP above the 95th percentile for age and height too.

2.3. Principal exposures

PA and SB levels were considered independent variables.

Physical activity: was measured using a uniaxial accelerometer (Actigraph model GT1M GT1M or ActiTrainer. The sensor unit of both models is identical). Recordings were for at least 6 h/d for at least 3 days (2 weekdays and 1 day of weekend/holiday). The sampling interval (epoch) was set at 15 s. A measure of average total volume activity (hereafter called total PA) was expressed as the sum of recorded counts divided by total daily registered time expressed in minutes (counts/min; cpm). The cut-offs to define the PA intensity categories were derived from previously-validated cut-offs [16], with time spent in light PA (minutes) defined as the sum of time-per-day in which counts per epoch were 26 to 573 cpm. The time engaged in moderate PA was calculated based upon a cut-off of 574 to 1002 cpm per epoch. The time engaged in vigorous PA was calculated based upon a cut-off of ≥1003 cpm per epoch. In addition, the time spent at the 'effective' intensity level was calculated as the sum of time spent in moderate + vigorous PA (MVPA).

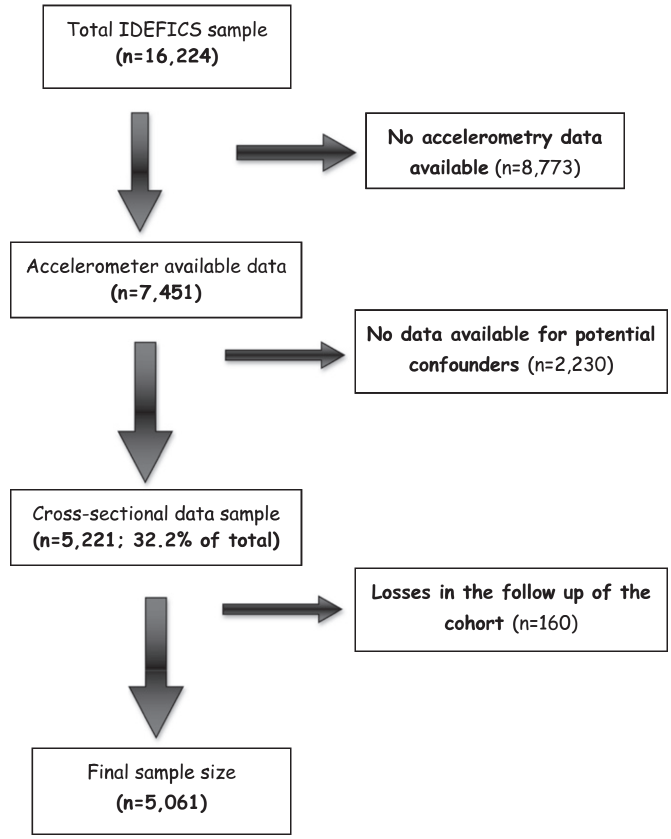

Fig. 1. Final sample size flowchart.

Following current PA guidelines [17], subjects were classified in T0 and T1 as: meeting current PA recommendations when they accumulated at least 60 min/d of MVPA and not meeting current PA recommendations when MVPA was <60 min/d. We also established the variable change in PA based on the distribution in PA categories in T0 and T1; subjects were classified into the following categories: always ≥60 min/d (meeting current PA recommendations in both T0 and T1); ≥60 min/d → <60 min/d (meeting current PA recommendations in T0 to not meeting current PA recommendations in T1); <60 min/d → ≥60 min/d (not meeting current PA recommendations in T0 to meeting current PA recommendations T1); and always <60 min/d (not meeting current PA recommendations in T0 and T1).

Sedentary behaviors: The parental questionnaire was used to obtain information on children's sedentary behaviors'. Parents reported hours of TV/DVD/video viewing and computer/games-console use both for a typical weekday and weekend day. For the purpose of the current analysis, children's daily TV/DVD/video and computer/games-console use were summed to obtain the total screen time per day (the whole week). The used questionnaire had previously been tested for its reliability and validity in this population [18].

Thereafter, participants were classified into two groups according to the American Academy of Pediatrics (AAP's) guidelines on total screen time: ≤2 h/d and >2 h/d [19]. We also established the variable change in SB based on the distribution in SB categories in T0 and T1; subjects were classified into the following categories: always ≤2 h/d (meeting current SB recommendations in both T0 and T1); ≤2 h/d → >2 h/d (meeting current SB recommendations in T0 to not meeting current SB recommendations in T1); >2 h/d → ≤2 h/d (not meeting current SB recommendations in T0 to meeting current SB recommendations T1); and always >2 h/d (not meeting current SB recommendations in T0 and T1).

2.4. Potential confounders

The potential confounders for this study were divided into two groups: Contextual Factors and Individual Factors, and described bellow:

Contextual Factors

Centres in 8 European countries: Belgium, Cyprus, Estonia, Greece, Germany, Hungary, Italy, Spain and Sweden.

Seasonality: A variable was computed by recoding the original variable "blood drawing date" into "seasonality", as follows: winter (from 21st December to 20th March, coded as 1), autumn (from 21st September to 20th December, coded as 2), spring (from 21st March to 20th June, coded as 3), and summer (from 21st June to