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Stunting does not impair physical fitness in Indonesian school children

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Abstract

Background Physical fitness is decreased in malnourished children and adults. Poor appearance and muscular flaccidity are among the first signs of malnutrition. Malnutrition is often associated with stunting.

Objectives We test the hypotheses that stunted children of low social strata are physically less fit than children of high social strata.

Sample and Methods We investigated 354 school girls and 369 school boys aged 5.83 to 13.83 (mean 9.54) years from three different social strata in Kupang (West-Timor, Indonesia) in 2020. We measured height, weight, and elbow breadth, calculated standard deviation (SDS) of height and weight according to CDC references, and the Frame Index as an indicator of long-term physical fitness, and we tested physical fitness in standing long jump and hand grip strength.

Results Children of low social strata are the physically fittest. They jump longer distances, and they have higher values in the Frame index. No association exists between height SDS and physical fitness, neither in respect to standing long jump, nor to hand grip strength.

Conclusion Stunting does not impair physical fitness in Indonesian school children. Our results support the concept that SEPE (social-economic-political-emotional) factors are involved in the regulation of human growth.

Take home message for students Chronic malnutrition has characteristic clinical signs including impaired physical fitness. Stunting is not a synonym of malnutrition. Stunted Indonesian children from low social strata are physically fitter than the stunted children from higher social strata.

Introduction

Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure (Westerterp 2013). Physical activity is decreased in malnourished children and adults. Slight manifestations of malaise, restlessness, an apparent intolerance for certain foods, a general poor appearance and muscular flaccidity are the first signs of first degree malnutrition (Feferico Gomez, Rafael Ramos Galvan, Joaquin Cravioto and Silvestre Frenk 1955; Behrman RE, Kliegman RM, Jenson HB. 1999). Stunting is the result of chronic or recurrent undernutrition, usually associated with poor socioeconomic conditions, poor maternal health and nutrition, frequent illness, and/or inappropriate infant and young child feeding and care in early life (WHO 2021). Stunting is frequent in Indonesia. The prevalence of stunting of children aged 5 – 12 years old was 30.7% in 2013 (Lestari et al. 2018). With a global hunger index of 22, Indonesia is considered "seriously" affected by starvation (K. von Grebmer, J. Bernstein, N. Hossain, T. Brown, N. Prasai, Y. Yohannes, F. Patterson, A. Sonntag, S.-M. Zimmermann, O. Towey and C. Foley. 2017).

In a recent study of stunted children in Indonesia we failed to detect the characteristic skin lesions of malnutrition (Scheffler et al. 2021). We also failed to detect signs of malaise and restlessness, and instead, found apparently healthy and mobile children. In order to depict the current level of physical fitness and exclude muscular flaccidity, we decided to also study standing long jump and hand grip strength. In order to estimate long-term activity, we measured the ratio: elbow breadth divided by body height (Frame Index (elbow breadth to height) by Frisancho (1993) as an indicator of skeletal robusticity and long-term level of physical activity (Rietsch et al. 2013). In view of the common perception that stunting holds children back from reaching their physical and cognitive potential (Research Institute, International Food Policy). We test the hypothesis that in a stunted population of Indonesians without clinical signs of malnutrition children of lower social strata (at higher risk of malnutrition) perform worse in tests of physical activity than children of higher social strata (at lower risk of malnutrition), children of lower social strata have lower values in Frame Index than children of higher social strata.

Sample and Method

We measured 723 school children, 354 girls, 369 boys aged 5.83 to 13.83 (mean 9.54) years, from Kupang, West-Timor, Indonesia, in March 2020. These were the entire bodies of students of two representative elementary state schools (middle social strata), situated close to the old harbor (222 boys, 230 girls), one Catholic private school (104 boys, 92 girls) for children of affluent parents who could afford school fees (high social strata), and one remote run-down school outside the urban area of Kupang (43 boys, 32 girls), some 50 min drive from the center of Kupang (low social strata). These children were impoverished and appeared different. They were less noisy than the children from the central urban schools were, they wore similar, but ragged and dirty school uniforms. Some had no socks or shoes. Several had scarves or healing wounds on feet and lower leg. An additional problem in this school seemed to be the inappropriate communication between teachers and pupils. Many children spoke their local languages with incomplete knowledge of the national Bahasa

Indonesia. We excluded two children because of poorly healed fractures of arm and leg that would have impaired the physical fitness test; one child refused cooperation. All measurements were performed in the presence of the children's teachers, and supervised and accompanied by 26 local physicians, pediatricians, and medical residents. The group of co-operators remained constant during the study, the variables were always obtained from the same observers. The children were lightly dressed, and measured without shoes.

Parental informed consent was given. Parents read and sign the appropriate form that was shown to us by the Indonesian colleagues. Ethical approval was provided by the Medical and Health Research Ethics Committee. Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada-Dr, Sardjito General Hospital; Ref.NO: KE/FK 1440/EC/2019, from 11 December 2019. All individual data were anonymized.

We measured body height (technical error 2.5 mm), weight (technical error 0.15 kg), and are looking for clinical signs of malnutrition e.g. hair, skin, and general appearance (Feferico Gomez, Rafael Ramos Galvan, Joaquin Cravioto and Silvestre Frenk 1955). Body height was determined by digital laser rangefinder GLM Professional® Bosch 250 VF (Schrade and Scheffler 2013) to the nearest millimeter, weight by digital scales (Soehnle, Nassau, Germany, Style Sense Compact 100) to the nearest 100g. All measurements were taken under standardized conditions (Knussmann 1988) as described in detail previously (Scheffler et al. 2021). We measured hand grip strength (kPa) of the dominant hand with a vigorimeter that was adjusted for children hand size. Each measurement consisted of two trials of which the second was taken. And we tested the distance of long jump. As the children clustered with much interest around the long jump group, we did not need to specifically instruct the children. Even the youngest children were able to correctly perform the jump. Each child was given one trial. We calculated standard deviation scores for grip strength and standing long jump (grip_SDS, Jump_SDS). We measured elbow breadth with a caliper and calculated the Frame index. It has previously been shown that skeletal robustness (relative elbow breadth) is associated with daily step counts (elbow breadth/height (Frisancho 1993). High values of Frame Index indicate high physical activity over a long time.

Standard deviation scores for height (hSDS) and weight (wSDS) were calculated according to CDC references (Onis et al. 2007) as WHO references do not provide data on weight above age 10 years. We also calculated SD scores for long jump and handgrip strength for age and sex adjustment as the different groups of children were comparably small. We compared data of different social strata with ANOVA performed scatter plots with the R package ggplot and calculated linear mixed models using the programming language "R" (R Core Development Team 2016).

Results

Body height standard deviation scores (hSDS) differed between social strata. Highest hSDS (mean -0.678, SD 1.10) were found in the high social strata, medium hSDS (mean -1.271, SD 0.96) in the middle social strata, and lowest hSDS (mean -1.673, SD 0.98) in the low social strata *($p<0.001$)*. Stunted children were found in all social strata. Body weight was lowest in the children of the low social strata with -2.10 wSDS (SD 1.18) and highest in the children of the high social strata with -0.42 (SD 1.64) *($p<0.001$)*. In contrast, the children of the

high social strata showed lowest values of the Frame Index (mean 37.6, SD 2.1), the highest values (38.5, SD 1.9) was detected in the children of the low strata *(p<0.001)*. Figure 1 illustrates physical performance in standing long jump (jump_SDS). Children of the high social strata performed poorest with -0.44 SDS (SD 0.86), children of the middle social strata showed average results with 0.14 SDS (SD 0.99), the poorest children performed best in long jump with 0.33 SDS (SD 0.96) *(p<0.001)*. The handgrip strength (grip_SDS) differed insignificantly between the social strata.

Figure 1 demonstrates lack of association between hSDS and long jump SDS (jump_sds) in any of the social strata. Figure 2 illustrates the association of height hSDS and handgrip strength SDS (grip_SDS) (high social strata, $p<0.001$, adj.R^2=0.14, middle social strata $p<0.001$, adj.R^2=0.08, low social strata $p=0.02$, adj.R^2=0.06). All associations are low. Very similar results were obtained for associations between physical fitness and body weight (wSDS). Body weight correlated low with grip strength SDS (grip_SDS) in high ($p<0.001$, adj.R^2=0.15), middle ($p<0.001$, adj.R^2=0.11), and low social strata children ($p<0.001$, adj.R^2=0.15).

Discussion

Stunting (low height-for-age) is considered to result from chronic or recurrent undernutrition, and to hold children back from reaching their physical and cognitive potential (WHO 2021). This vision is almost ubiquitously prevalent but has recently been questioned. Stunting is not a synonym of malnutrition (Scheffler et al. 2019), but may rather be considered a synonym of social disadvantage and poor parental education (Scheffler et al. 2021), and related to socio-economic-political and emotional (SEPE) factors (Bogin 2021). In the present study, we investigated physical fitness in severely stunted children from West Timor, Indonesia. The children originated from different social strata, they went to school, and appeared healthy. They were physically active though to a different extent. Particularly the children of the lowest social class showed the most eye-catching signs of activity, with highest values of Frame Index, indicating long-term vigorous physical exercise (Frisancho 1993; Rietsch et al. 2013) and best results in standing long-jump, even though many of them exhibited multiple skin infections of feet and ankles as they could not afford socks and shoes. Recent work on Frame Index of different populations including those nutritionally at risk (Mumm et al. 2018) suggests this parameter as a relevant estimator of physical activity and fitness.

We failed to verify the hypotheses that stunted children are physically less fit. The effect of social disadvantage on motor development in young children has occasionally been shown (McPhillips and Jordan-Black 2007). But though a relatively rich literature addresses fitness of children in developing countries, assessing a range of cultural and social factors and/or physical environmental factors in development, these studies show inconsistent results (Barnett et al. 2016) and support the present findings. We are aware that standing long jump and grip strength measure specific components of fitness, power and static strength, respectively, and are not indicators of overall physical fitness. The jumping pattern which underlies the standing long jump may be influenced by early nutritional status and a number of the school age children may not have attained the mature movement pattern – which will likely affect the distance jumped. Yet, neither body height, nor body weight, nor social status and economic affluence of the

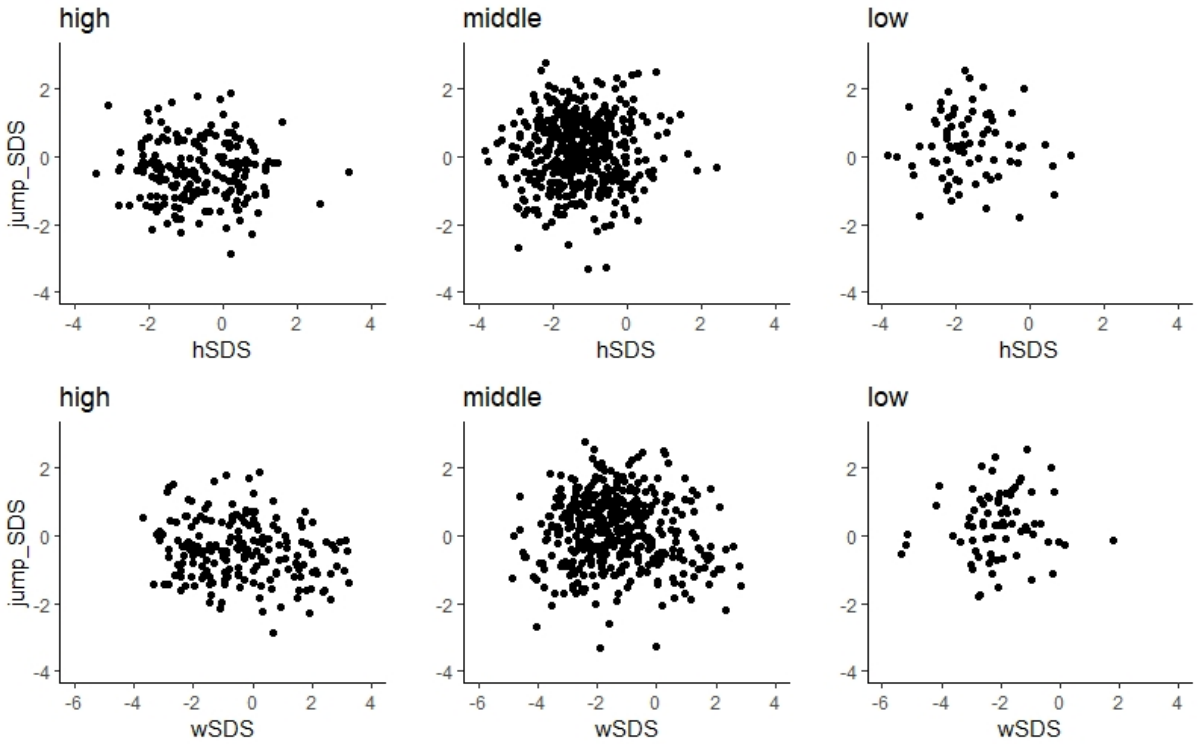

Figure 1 Association of to handgrip-strength (grip_SDS) of Indonesian primary school children of high, middle, and low social strata (hSDS: high *p<0.001*, adj.R^2=0.14, middle *p<0.001*, adj.R^2=0.08, low *p=0.02*, adj.R^2=0.06wSDS: high *p<0.001*, adj.R^2=0.15, middle *p<0.001*, adj.R^2=0.11, low *p<0.001*, adj.R^2=0.15).

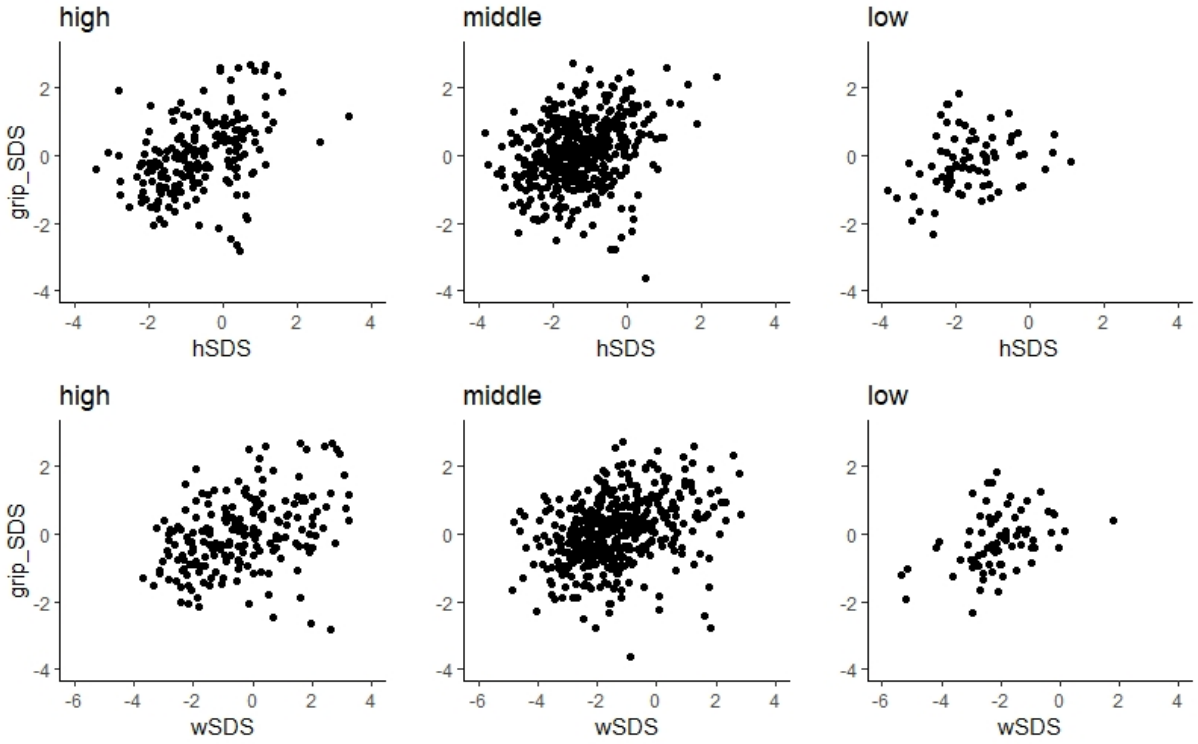

Figure 2 Association of to handgrip-strength (grip_SDS) of Indonesian primary school children of high, middle, and low social strata (hSDS: high *p<0.001*, adj.R^2=0.14, middle *p<0.001*, adj.R^2=0.08, low *p=0.02*, adj.R^2=0.06wSDS: high *p<0.001*, adj.R^2=0.15, middle *p<0.001*, adj.R^2=0.11, low *p<0.001*, adj.R^2=0.15).

parents was associated with standing long jump and grip strength not even in children from the poorest social background. We do not deny that caloric restriction impairs physical growth, and leads to a plethora of characteristic clinical symptoms such as hyperchromic skin, follicular hyperkeratosis, dermatitis, muscular flaccidity and general weakness, frequent illness, and in the long run, cognitive restraints. However, the symptom "being shorter than given cut-offs of body height" cannot be used as an appropriate indicator of impaired child development in the Low and Middle Income Countries. Quite the opposite, the starting obesity epidemic in the upper social class children of Kupang, West Timor, coincides with a decline in physical fitness discernible by the decreased skeletal robustness and the poor performance in standing long jump.

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