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Physical Growth of Sasak Children at Different Altitudes in Lombok Island

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The physical growth that occurs in schoolage children makes this period one of the most important phases in the human life cycle. Within this period, puberty is indicated by growth spurts that increase both stature (BH) and body-weight (BW). The focus of this research was to evaluate the age-related body size variation in Sasak children living at different altitudes on the island of Lombok, Indonesia: low, medium, and high. Our results showed that children living at low altitude were taller and heavier than children of the same age living at medium and high altitudes. Up until the onset of puberty, the children at medium altitude have similar stature and weight to those residing at high altitude, but they are shorter and lighter thereafter. There were significant differences in the height and weight of girls in different altitude locations, but no significant difference for boys. The effect of SES on child growth can be comparison between Sasak and other populations in Indonesia. In general, the Sasak children are shorter and lighter than children of the same age in urban populations, and relatively similar in size to the children in rural populations. Indicators of socioeconomic status such as family income and parental education were shown to be more influential factors in the differentiation of physical growth between populations than the altitude factor

Key words: altitude, growth, stature, body weight, Sasak

INTRODUCTION

The human life cycle can be classified into stages as follows: neonatal (birth to 28 days), infancy (1 to 36 months), childhood (3 to 7 years), juvenile (7 to 12y), puberty (transition between juvenile to adolescence; lasting for days or few weeks at 12 to 15y), adolescence (5 to 8y after the onset of puberty), adulthood (20y to end of child-bearing years), and senescence (end of child-bearing years to death). The age of schooling (6 to 20y) is one of the important phases in human life cycle because during these years, the body changes significantly in size, structure, proportions, and composition (Bogin 1999). Within this age range, the stage of puberty is indicated by growth spurts that increase stature (BH) and bodyweight (BW). These two characters are anthropometric measurements used to determine the body size.

Both genetic and environmental factors contribute to body shape and size variations during development. For instance, children who live in high altitude environments face numerous stresses, including hypoxia, cold climate, ultraviolet radiation, and rough and difficult terrain. These conditions require greater physical and physiological activity from children, than the conditions in low altitude (Hastuti 2005; Malhotra *et al*. 2006; Singh *et al.* 2007). Several studies show a pattern low birth weight and reduced childhood growth in people living at high altitude (Yip *et al*. 1988; Jensen & Moore 1997; Lestari 2006). However, other studies have found little or no difference in growth between children living at low and high altitudes (Freyre & Ortiz 1988; Hastuti 2005). Socioeconomic statuses (SES), such as parent education, occupation and monthly income, widely influence the growth of children (Eiben & Mascie-Taylor 2004; Bener & Kamal 2005; Bala *et al.* 2010; Lazzeri *et al*. 2011; Widiyani *et al*. 2011).

The focus of this research was to evaluate the age-controlled variation in body size of Sasak children residing at different altitudes. Our subjects were Sasak school children who live on Lombok Island, Indonesia at one of three different altitudes; that is, low, medium, and high altitudes. We found significant differences in BH and BW between girls at different altitudes, but no such difference for boys. Overall, children in low altitude populations were taller and heavier than children from medium- and high-altitude populations. Until puberty, the children at medium

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altitude have similar stature and weight to same-aged children that reside at high altitude; however they are shorter and lighter thereafter. Family income and parental education, rather than the altitudinal factor, exerted more influence on the differentiation.

MATERIALS AND METHODS

Subject. The subjects in this research are children of the Sasak ethnic who live at different altitudes in Lombok Island, West Nusa Tenggara province, Indonesia. A cross sectional sampling was conducted from July to December 2012. Population samples were taken of students from kindergarten to senior high school-age, aged 3 to 19y (Table 1). All subjects are rural children who lives in one of 3 altitudes: low (16 to 28 m above sea level), medium (525 to 628 m asl), and high altitudes (1130 to 1213 m asl). A Global Positioning System (Garmin Etrex 10 GPS) was used to determine the altitude. Before embarking on the present research, a letter with detailed information about this study was sent to the parents or guardians of children in the kindergarten and elementary school samples to ask their consent for their child's participation. Junior and senior high school subjects were asked directly for their informed consent. If they agreed to participate, they were asked to sign the informed consent form and to complete a questionnaire on demographic and socioeconomic status. Data analysis was conducted at Section of Biosystematics and Ecology of Animals, Department of Biology, Faculty of Mathematics and Natural Sciences, Bogor Agricultural University.

Measurements. BH is a linear measurement, for a standing person, of the distance from the standing surface to the top (vertex) of the skull; it is a composite of linear dimensions contributed by the lower extremities, the trunk, the neck, and the head. It was measured to the nearest 1 mm using anthropometer. BW is a measure of body mass; it is a composite of independently varying tissues. BW was measured using digital weight scale with 100 g resolution.

Sosioeconomic Status (SES). The SES of the children was ascribed to them based on the SES of their parents. SES is a concept that encompasses aspects of formal education (schooling), occupation and monthly income (Bogin 1999). Six educational levels, ten occupational categories and five monthly incomes of parents were used to identify the SES. The regional minimum wage UMP (Upah Minimum Provinsi) of West Nusa Tenggara (Nusa Tenggara Barat, NTB) province was used as a benchmark for family income. UMP is regulated every year by local government based on the rates of several goods essential to life in an area. It is a standard used by industry in paying their single (unmarried, no family) male laborers or employees. The regional minimum wage of NTB in 2013 is IDR 1,100,000.

Data Analysis. Growth data for BW and BH were charted against age, and were fitted by applying generalized additive models for location, scale and shape (GAMLSS) (Rigby & Stasinopoulos 2005). We predicted nine percentile-increments (3, 5, 10, 25, 50, 75, 90, 95, and 97%) to describe the pattern of growth. Velocity is the rate of growth (cm/y or

Table 1. Site sampling of Sasak children

Name of the school	Number of samples
Low altitude	408
TK Satu Atap SD 1 Labuan Tereng , West Lombok	19
SD 1 Labuan Tereng, West Lombok	31
SD 4 Batulayar, West Lombok	46
SMP 1 Batulayar, West Lombok	144
SMK Pariwisata Batulayar, West Lombok	126
SMK Perikanan Lembar, West Lombok	42
Medium altitude	271
PAUD Mawar Rindang Tetebatu, East Lombok	19
SD Sekedek, Central Lombok	96
SMP 3 Batu Kliang Utara, Central Lombok	82
MA Nurussalam Tetebatu, East Lombok	74
High altitude	273
PAUD Sembalun Bumbung, East Lombok	17
SD 2 Sembalun Bumbung, East Lombok	113
SMP 2 Sembalun Bumbung, East Lombok	86
SMA 1 Sembalun, East Lombok	57
Total	952

TK and PAUD are Kindergarten School Level; SD is Elementary School Level; SMP is Junior High School Level; SMA, SMK and MA are Senior High School Level.