Predictors of Height in Romanian Infants 6-23 Months Old:

Findings from a National Representative Sample

Ecaterina Stativa
The National Institute for Mother and Child Health "Alessandrescu-Rusescu",
Bucharest, Romania
kattyshu@yahoo.com

Adrian V. Rus*
Southwestern Christian University, Oklahoma, USA
adrian.rus@swcu.edu

Wesley C. Lee, Ph.D.
Southwestern Christian University, Oklahoma, USA
wesley.lee@swcu.edu

Kailei A. D. Salinas
Mid America Christian University, Oklahoma, USA
kailei.salinas@gmail.com

Hannah M. Cossey
Southwestern Christian University, Oklahoma, USA
hmcossey@gmail.com

Austin Lobo
Sacramento, California, USA
austinlobo24@gmail.com

Michaela Nanu
The National Institute for Mother and Child Health "Alessandrescu-Rusescu",
nanu.micka@gmail.com

* Correspondence concerning this article should be addressed to Adrian V. Rus,
Southwestern Christian University, Department of Social and Behavioral Sciences,
7210 NW 39th Expressway, Bethany, OK 73008-0340

E-mail: adrian.rus@swcu.edu | avr@pm.me
Office: (405) 789-7661 ext. 3467 | Fax: 405-495-0078

Background. The research explored the association between infants' height and various demographic factors in Romania, a country where such critical information has been lacking.

Methods. This study was conducted on a nationally representative sample and used a family physicians database to determine a sample of 1,532 children (713 girls and 819 boys) 6 to 23 months of age (M = 14.26; SD = 5.15). Infants' height-for-age z-scores (HAZ) were calculated using the World Health Organization's computing algorithm. A multiple regression analysis was conducted to investigate whether certain risk factors, such as infant mother's age, location, marital status, socioeconomic status (SES), as well as infant's term status at birth, age, anemia, minimum dietary diversity (MDD), and birth order, could significantly predict the HAZ.

Results. The study identified several significant predictors of height. Specifically, lower HAZ was associated with rural living, preterm birth, age 18-23 months, unmarried mothers, anemia, lack of MDD, and being third or later born in the family. In contrast, higher HAZ was associated with medium or high maternal socioeconomic status and older maternal age.

Conclusions. The study underscores the importance of addressing these significant risk factors through distinct interventions to improve height outcomes in at-risk Romanian populations.

Keywords: Romanian Infants, Height (Height-For-Age z-Scores), Public Health

Introduction

In public health domains, height-for-age z-scores (HAZ) are deemed a pivotal metric. These scores, which compare an infant's height to a reference population, are instrumental in detecting growth deviations such as stunting or accelerated growth. Notably, stunting often signals chronic malnutrition, with significant repercussions on an infant's cognitive and physical development. A myriad of factors, from genetic makeup and physical condition to nutrition, socio-economic factors, influence this growth pattern.[1,2,3,4,5]

Romania, with its distinct socio-cultural and economic landscape, remains underrepresented in this discourse. While global insights offer a comprehensive perspective, regional nuances often demand specialized studies. This literature void prompts an essential query: What drives the height of Romanian infants aged 6 to 23 months? This paper sought to unravel this question.

Drawing from a nationally representative sample, our study endeavored to pinpoint the primary factors influencing the height of Romanian infants in the specified age bracket. Beyond augmenting existing knowledge, our aim was to furnish actionable insights for targeted interventions benefiting at-risk groups, thereby aiding Romania's policymakers and healthcare practitioners. Our objective was to investigate the relationship between infants' height and various demographic parameters, including the mother's location, marital status, socioeconomic status, age, and infant-specific factors such as being born at term, age, anemia condition, birth order, and dietary patterns, specifically minimum dietary diversity (MDD).

Methods

Participants

This study utilized data from an extensive cross-sectional survey carried out by Stativa et al.[6] in the latter half of 2010. The overarching study, titled “Assessment of the Current Situation of Breastfeeding and Nutrition Practices for Children from Birth to Two Years Old,” aimed to enhance the access, quality, and efficiency of medical services for pregnant women and infants up to two years of age. The first segment of the study assessed the national iron supplementation program, while the second delved into breastfeeding and nutritional practices among infants, identifying factors that influence these practices. The insights garnered from this research informed the creation and execution of policies and programs to bolster the nutritional status of infants nationwide. Prior to the study’s commencement, all participating parents (specifically the children’s mothers) provided written consent to the National Institute for Mother and Child Health “Alessandrescu-Rusescu” in Bucharest, Romania. Data from this primary study was also employed in a subsequent article that scrutinized the feeding patterns of infants aged 6-23 months.[6]

For this secondary analysis, our sample comprised 1,532 children (713 girls and 819 boys) aged between 6 to 23 months (M = 14.26; SD = 5.15).

Procedure

The study employed a stratified multistage probabilistic sampling strategy. The population was segmented based on geographical regions, encompassing the eight macro-development regions in Romania, and further categorized by residence (urban vs. rural). Within these strata, participants were grouped into age brackets: 0-3 months, 3-6 months, 6-11 months, 11-13 months, 13-18 months, 18-23 months, and 23-25 months. This approach aimed to account for potential regional variations in infant nutrition practices based on age. From each region, two counties were chosen. Within these counties, two urban and three rural areas were randomly selected, using the 2009 Statistical Yearbook of Romania as a reference. For the Bucharest-Ilfov region, two sectors (districts) from six, and an additional urban locality outside Bucharest were chosen, along with two rural areas.

Medical inspectors and nurses from the County Directorates of Public Health collaborated with research teams to aid in the selection of family doctors from both urban and rural localities. In urban areas, 4-5 family doctors were selected. In contrast, for rural areas, while considering the existing family doctors, a maximum of 2 were recruited for the study. Family doctors were instructed to randomly select a certain number of children from all age groups defined, with the reference age being the number of months completed until the date of the visit of the research teams. Doctors were instructed to select and reserve children in case they did not show up. For children selected in the sample, nurses telephoned families about the research and asked for their verbal consent to participate. Written consent was obtained at the scheduled presentation at the family doctor's office. The research teams verified on site their compliance with the requirements for randomized selection and noted, if necessary, that the child was not randomly selected and was excluded from the data analysis.

Interviews were conducted with mothers who brought the children chosen for the sample. A subset of the 17-member team, specifically 2-3 trained and seasoned researchers, carried out these interviews. Following the interviews, these researchers took blood samples from the children and recorded their height and weight measurements. At the family doctors' clinics, mothers were inquired about their prenatal consultation experiences and their use of iron prophylaxis during the pregnancy under investigation. Additional inquiries covered topics such as the mother's initiation, understanding, and practices related to breastfeeding; child feeding habits; maternal smoking history; and the use of iron and vitamin D prophylaxis.[7,8] The data was collected between July and November 2010.

The study encompassed 2,117 children spanning 16 counties, effectively covering all eight regions of the nation. Of this cohort, 51% (1,080) were from urban settings, while 49% (1,037) hailed from rural locales. Age-wise, 1,002 children (47.3%) were between 0-12 months, and 1,115 (52.7%) were older than a year.

Variables

The dependent variable used in this study was child HAZ, calculated using the World Health Organization's algorithm.[8]

Several demographic variables related to mothers served as independent variables in our study. These included the mother's age (in years) and categorical variables such as location (urban vs. rural), marital status (categorized as married vs. others, with "others" encompassing cohabitation, divorced/separated/widow, and unmarried). SES of the mother was also considered, segmented into low, medium, or high. SES determination was based on the ownership of 12 items, ranging from basic household appliances to luxury goods. Ownership of up to four items was classified as low SES, five to eight items as medium SES, and ownership of nine or more items indicated high SES.

Infant characteristics were also factored in as categorical independent variables. These encompassed the infant's age (grouped as 6-11 months, 12-17 months, or 18-23 months), term status at birth (categorized as 37-40 weeks [at term] vs. 27-36 weeks [preterm]), birth order (firstborn, second-born, or third and subsequent), and hemoglobin level (no anemia vs. anemia). For hemoglobin determination, capillary blood samples were taken from presumed healthy infants using a finger-prick method. Hemoglobin concentration was measured with a portable hemoglobinometer (HemoCue), and parents were subsequently informed about their child's iron status. Hemoglobin concentration was categorized into two levels: no anemia (>11.0 g/dl) and anemia (<11 g/dl).

Furthermore, the study incorporated the World Health Organization's[9,10] minimum dietary diversity (MDD) for analysis. MDD represents the proportion of children aged 6–23 months who consumed food from four or more of the seven designated food groups the previous day. These groups included (1) grains, roots, and tubers; (2) legumes and nuts; (3) dairy products (e.g., milk, yogurt, cheese); (4) flesh foods (e.g., meat, fish, poultry, and liver/organ meats); (5) eggs; (6) vitamin-A rich fruits and vegetables; and (7) other fruits and vegetables. MDD was dichotomized, with category 1 indicating adherence to the complementary feeding indicator and category 2 indicating non-adherence.

Analyses

All analyses, including accuracy of data coding and entry and the statistical assumptions of the tests, were conducted using SPSS[11] and JASP[12]. The analyses were conducted with all available data (pairwise deletion) and no imputation was conducted due to the small percentage of missing cases. There are several compelling reasons to choose this technique. Primarily, it excels in harnessing the power of in-depth data analytics, guaranteeing the most effective use of available information. Especially in scenarios with sparse missing data across multiple variables, pairwise deletion becomes invaluable, minimizing drastic reductions in sample size. When data is missing entirely at random, pairwise deletion produces parameter estimates that are closely aligned with those obtained from a complete dataset analysis.[13,14] A multiple regression (forced entry method) was used to determine the best predictors of children's HAZ. The forced entry method in multiple regression is favored for its theoretical justification, simplicity, reduced overfitting risk, model stability, and potential for greater generalizability. Its usage hinges on the researcher's theoretical foundation and data characteristics.[15]

Results

Table 1 presents the characteristics of the sampled infants and their mothers. Of the 1,532 infants, 819 (53.5%) were male, and 593 (38.7%) were aged between 6-11 months. A majority, 789 (51.5%), lived in urban areas with their mothers. Most mothers identified as Romanian (84.3%), were married (81.4%), and fell into the medium socio-economic status bracket (48.4%). Additionally, over half of the children were first-born (54.8%) and were born at term (89.9%). Notably, 49.9% of the infants had anemia, 76% met the criteria for minimum dietary diversity (MDD), and 54.8% were the eldest in their families. The multivariate linear regression (see Table 2) demonstrated that the independent variables had a significant negative and positive impact on the dependent variable. The overall result of the regression (R^2) indicated that 9% of the variance in the data was explained by the predictor variables [F (9,1522) = 16.125, $p <$ 0.001]. A relatively low R^2 value suggests that a significant proportion of the variability in the dependent variable remains unexplained by the current model. This indicates that the model may not encompass all relevant predictors. Factors such as genetic makeup, specific medical conditions, or other pertinent socio-economic conditions might play a crucial role in influencing HAZ.

On average, infants living in rural areas had significantly lower HAZ (B = -0.30, p = 0.001) compared to those in urban areas. Infants not born at term had significantly lower HAZ (B = -0.65, p < 0.001) compared to those born at term. Infants aged 18-23 months had significantly lower HAZ (B = -0.54, p < 0.001) compared to those aged 6-11 months. Infants with unmarried mothers had significantly lower HAZ (B = -0.24, p = 0.032) compared to those with married mothers. Infants with anemia had significantly lower HAZ (B = -0.29, p < 0.001) compared to those without anemia. Infants without MDD had significantly lower HAZ (B = -0.23, p = 0.015) compared to those with MDD. Infants who were third-born or later had significantly lower HAZ (B = -0.54, $p < 0.001$) compared to firstborn children.

Conversely, children whose mothers had a medium SES had significantly higher HAZ (B = 0.31, p = 0.013) compared to those with mothers of low SES, and this was even higher for children whose mothers had a high SES (B = 0.41, p = 0.003). Children with older mothers had significantly higher HAZ (B = 0.02, p = 0.018) compared to those with younger mothers.

Discussion

Main Finding of This Study

While the study reaffirms certain established knowledge, it offers nuanced insights into the determinants of infant HAZ within the Romanian demographic. The research highlighted that Romanian infants' HAZ is influenced by a myriad of factors. Specifically, residing in rural areas, being born preterm, being aged 8-23 months, having unmarried mothers, suffering from anemia, lacking sufficient MDD, and being third-born or later were all associated with decreased HAZ. Conversely, infants with mothers from a higher SES background or of advanced age exhibited enhanced HAZ.

What Is Already Known on This Topic

Geographical disparity. The relationship between geographical location and height growth is complex and not fully understood. Therefore, geographical disparity should be interpreted with caution, as some studies support[16,17] and others reject[18,19] the claim that infants raised in urban areas have greater exposure to resources that increase height growth compared to infants raised in rural areas.

Born at Term. Literature on prematurely born infants presents mixed findings. While many exhibit low birth weight and reduced HAZ, they often undergo rapid growth in their first year, aligning with or even surpassing the growth rates of full-term infants.[20] Gong at al.[21] suggest preterm infants often surpass the growth rates of full-term infants and Barreto and colleagues[22] indicate that, despite starting with a lower birth size, many preterm infants experience a growth spurt between months 6-23, reaching typical sizes. Yet, Finken at al.[23] contend that preterm children largely develop at standard rates.

Infants' Age. Several studies indicate that infants aged 18-23 months are more prone to stunting in height growth compared to their younger counterparts. Specifically, one Marriot and colleagues[1] highlighted that over half of the children in the 18–23 months age group exhibited signs of stunting. A study of Burundian[24] children under two found that 58% of children aged five and below are affected by stunting. Older infants, specifically 12-17 and 18-23 months, were at higher risk, as were infants with low birth weight, poor nutritional assessments, and mothers with low education levels. Additionally, 79.3% of stunted infants were between the ages of 12-23 months. A growing body of evidence suggests that stunting can be attributed to a variety of factors, including the rapid growth spurt that occurs during this age, the introduction of complementary foods, and an increased risk of infection.[2,3,4]

Marital status. Reurings et al.[25] found that maternal marital status is closely tied to HAZ. Specifically, Amadu and colleagues[26] suggests that children in single-mother households using clean cooking fuel, and those in married households using unclean fuel, face higher stunting risks than children in married households with clean fuel. Female children in households with married, educated parents, non-pregnant maternal figures, and water-sealed toilets are less malnutrition-prone.[27] Infants with unmarried mothers often show more stunting than those with married mothers.[28,29] Yet, Young and Declercq[30] showed children from two-parent households generally have better height growth, regardless of marital status. While maternal marital status can influence growth, it is not the primary factor, especially for unmarried mothers, with education often being a key determinant.[31]

Iron deficiency. Results consistent with other studies have been reported.[32,33] Stativa and colleagues[34] conducted a study using a nationally representative sample in Romania, evaluating 1,532 infants aged between six months and two years. They discovered that 46% of these infants were anemic. The high prevalence of anemia among Romanian children has become a significant concern for specialists in the country, especially considering its potential long-term developmental consequences.

Feeding patterns. Diet diversity significantly predicts stunting in developing infants. Ahmad at al.[35] revealed that access to a diverse diet reduces stunting risk by 83%. In research conducted by Khamis and colleagues[36] and involving 2,960 children, it was found that 74% did not meet the MDD criteria, with 31% experiencing stunting, 6% wasting, and 14% being underweight. However, some studies[37,38] found no significant impact of MDD on infant height growth or stunting. Complementary feeding is recommended around five months, but only 66.4% of infants in northern Ghana received it on time[38]. Assisted feeding practices had a negative impact on growth, especially in the 6-11 months and 12-17 months age ranges[39]. Although infants aged 18-23 months may experience stunted growth, their mortality rates remain largely unaffected[40].

Birth order. Firstborns typically exhibit greater height, with the HAZ disparity doubling for children born third or later when siblings are spaced less than three years apart.[41] Yet, this difference diminishes with a three-year or larger gap. Families surpassing the perceived ideal size risk adverse growth effects in children.[42] In contrast, in a study where weight, HAZ, and hemoglobin levels were assessed, no correlation was found between birth order and ideal family size.

Socio-economic status. Devakumar et al.[43] indicated a positive link between HAZ and weight-for-age z-scores concerning stunting and underweight infants, particularly when considering SES. However, an infant mother’s SES can sometimes yield contrasting effects.[44] Specifically, mothers with lower SES often prioritize breastfeeding and infant care, unlike higher SES mothers who may be career focused. Contrarily, Palanichamy and Solanki[45] suggest that low SES affects weight more than height, challenging the prevalent belief of its impact on stunting.

Age of mothers. Yu et al.[46] as well as Wemakor at al.[47] links low HAZ to young maternal ages. Yet, when considering factors like maternal height and SES, these findings vary. Stunted growth rates in children are reported as 9% in Asia, 14% in Africa, and 10% in Latin America, regardless of maternal age.[46] Children over 24 months with younger mothers consistently show poor growth. Infants of mothers under 20 are eight times more prone to stunting, three times to wasting, and 13 times to being underweight.[46,48] Conversely, infants of mothers over 40 have low HAZ at birth, but this doesn't persist.[49,50]

What This Study Adds

This study uniquely centers on Romania, a country often overlooked in global HAZ research. Given Romania's unique socio-cultural and economic context, prior research missed specific regional HAZ determinants. Our sampling strategy ensured national representation, encompassing all eight of Romania's macro-development regions and differentiating urban from rural areas.

Limitations Of This Study

While HAZ is commonly used to describe child growth, its suitability for longitudinal growth tracking has been questioned due to its reliance on cross-sectional standard deviations. Authors[55] suggest using HAZ differences for linear growth measurement. This study incorporates socio-economic status but uses a non-validated categorization based on owned possessions. While suitable for Romania, the lack of validation may limit broader applicability. Future studies should validate this approach for Romania. The study's cross-sectional design precludes inferring causal relationships between variables.

Conclusion

This study delves into HAZ determinants for Romanian children, a topic previously under-researched. It enhances our understanding of factors leading to stunting. The findings underscore the need for age-specific interventions, promoting maternal education, improving nutrition, and addressing socio-economic disparities. By targeting these areas, we can reduce stunting, benefiting children’s health in Romania and similar settings.

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