



Gross motor development in full-term Greek infants assessed by the Alberta Infant Motor Scale: Reference values and socioeconomic impact



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ABSTRACT

Objective: The aims of this study were to investigate gross motor development in Greek infants and establish AIMS percentile curves and to examine possible association of AIMS scores with socioeconomic parameters.

Methods: Mean AIMS scores of 1068 healthy Greek full-term infants were compared at monthly age level with the respective mean scores of the Canadian normative sample. In a subgroup of 345 study participants, parents provided, via interview, information about family socioeconomic status. Multiple linear regression analysis was performed to evaluate the relationship of infant motor development with socioeconomic parameters.

Results: Mean AIMS scores did not differ significantly between Greek and Canadian infants in any of the 19 monthly levels of age. In multiple linear regression analysis, the educational level of the mother and also whether the infant was being raised by grandparents/babysitter were significantly associated with gross motor development ($p = 0.02$ and $p < 0.001$, respectively), whereas there was no significant correlation of mean AIMS scores with gender, birth order, maternal age, paternal educational level and family monthly income.

Conclusions: Gross motor development of healthy Greek full-term infants, assessed by AIMS during the first 19 months of age, follows a similar course to that of the original Canadian sample. Specific socioeconomic factors are associated with the infants' motor development.

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1. Introduction

The Alberta Infant Motor Scale (AIMS) is a norm-referenced test that assesses, via observation, the spontaneous motor performance of infants from birth through independent walking (0–18 months). Its application is simple and the results are easy to interpret for all health professionals who are familiar with infant motor development. It has been designed to assess gross motor maturation, to trace motor retardation and to identify infants that might benefit from early intervention. In addition, AIMS may also be useful in designing and monitoring a treatment program [1–4].

AIMS has been broadly employed throughout the world in many studies and in daily clinical practice to evaluate motor development in full term and preterm infants. It has also been used to investigate the influence of several medical and environmental factors on the infant's motor development [5–17]. However, it has been questioned whether

the scores of the original Canadian sample could be representative of those of infants of other nationalities. In addition, the applicability of the reference values in contemporary infant population has been doubted, mainly because the original sample was assessed before the Sudden Infant Death Syndrome (SIDS) "back to sleep" campaign [18,19]. Some argue that, following the "back to sleep" campaign, many parents exaggerated with the supine sleep position (even during the awake time), thus not providing their infants the opportunity to develop their motor milestones [20–22]; this practice might have affected the applicability of the original reference values of the AIMS.

The aim of the present study was to evaluate the gross motor development of Greek full-term infants by AIMS and establish AIMS percentile curves; furthermore, it also aimed to examine possible association of AIMS scores with socioeconomic parameters.

2. Methods

2.1. Sampling

A cross-sectional sample of 1068 healthy, full-term infants, aged between 7 days and 19 months, was assessed using the AIMS. The

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sample was derived from maternity and pediatric clinics, public and private day care centers, and private pediatricians' offices located in various areas of the Prefecture of Attica. It is an original study that follows our preliminary (pilot) study [23]. Sampling began in January 2008 and was completed in May 2013. Greek infants who were >37 weeks of gestation and who weighed at birth ≥ 2500 g were included, whereas infants with a history of perinatal problems, neurological diseases, as well as those suffering from any acute or chronic illnesses were excluded.

During the last 19 months of the study, the research protocol was modified in order to evaluate possible association between socioeconomic variables and infants' motor development. In a group of 375 infants consecutively assessed by AIMS during the period October 2011–May 2013, a questionnaire evaluating the socioeconomic status of the family (child's gender, birth order, maternal age, maternal educational level, paternal educational level, person responsible for infant's raising, and monthly family income) was administered to parents; the response rate was 345/375 (92%). Most of the issues assessed by the questionnaire, except for the parameter that evaluates whether the infant is being raised by parents or other person (grandparent-babysitter), are commonly used in other relevant studies evaluating the impact of socioeconomic status on infants' neurodevelopment [24]. As regards the person responsible to infant raising, we evaluated whether the infants of working parents were raised by grandparents or babysitters for at least 8 h per day for 5 days per week. The percentage of infants attending private of public day care centers was equal; all infants derived from day care centers (private or public) were attending the day care centers for 5 working days per week.

The study protocol was approved by the Ethics Committee of "Aghia Sophia" Children's Hospital and informed parental consent for gross motor assessment of their infants by AIMS was also obtained.

2.2. Assessment tool

The AIMS consists of 58 items at four different positions (prone: 21 items, supine: 9 items, sitting: 12 items, and standing: 16 items). The components tested for each item are based on three elements of movement (weight bearing, posture and antigravity movements). For any item observed by the examiner, one (1) point is given, whereas zero (0) point is given when the item is not observed. The sum of all the items observed gives the total raw score of AIMS, which may range from 0 to 58. The total raw score can also be converted into a percentile rank, which can be easily understood by parents as the majority of them are usually familiar with other percentile ranks, such as those corresponding to infant's anthropometric parameters. High percentile ranks indicate a relative maturity of the infant's gross motor skills, whereas low percentile ranks indicate a relative immaturity.

The duration of assessment of each infant spans from 10 to 30 min [1–4].

2.3. Reliability assessment

Evaluation of inter-rater reliability, among three independent examiners who had received adequate training prior to the onset of the study, was performed in a random sample of 87 participants as reported in our previous pilot study [23]; examination procedure had been videotaped. The examiners participating in the reliability assessments were pediatric physical therapists with extensive experience in the evaluation of psychomotor development of infants. They were all trained in the use of AIMS by attending a specific course, and had also applied AIMS in an adequate number of infants for at least a 3-month period prior to the initiation of the present study. Inter-rater reliability of the AIMS score assessment revealed a high degree of agreement among the three examiners (ICC: 0.996; 95% CI: 0.995, 0.997) [23].

2.4. Statistical analyses

Power analysis was performed prior to the onset of data collection; the sample size calculation of each monthly age level was based on the previously reported Canadian study of Piper and Darrah [3]. Kolmogorov–Smirnov test was used to test the assumption of normality. We tested by Student's *t*-test at each age level whether the mean AIMS scores of 1068 full-term Greek infants differed from the respective mean AIMS scores of the 2202 Canadian norm-reference sample [3].

In the subgroup of 345 infants, the impact of parental socioeconomic parameters on the infants' motor development was assessed using Student's *t*-tests or ANOVA, as appropriate, so as to compare the mean AIMS scores among different categories. The monthly age distribution of the subgroup of 345 infants did not differ significantly than that of the whole study population. Further on, the data were modeled through multiple linear regression analysis, using AIMS scores as the dependent variable and all socioeconomic parameters, namely, child's gender, birth order, maternal age, maternal educational level, paternal educational level, person responsible for infant's raising and monthly family income, as predictor variables. Before including all predictor variables simultaneously in the same multiple linear regression model the issue of multicollinearity was tested with no evidence for a significant association among them. Significance level was set at $p \leq 0.05$. The SAS statistical package (Version 9.1, SAS Institute Inc, Cary, NC) was used.

3. Results

The study population consisted of 602 (56.4%) boys and 466 (43.6%) girls. The mean \pm SD birth weight was 3260 ± 387 g and gestational age was 38.4 ± 0.4 weeks. Sample distribution of our study population and the mean \pm SD AIMS scores at each age level in comparison with the Canadian normative sample are shown in Table 1.

As expected, the mean AIMS scores increased in accordance with the age increase of our study population (Table 1). Boys and girls demonstrated similar motor behaviors at all age levels. Mean AIMS scores of our study population did not differ significantly than the respective values of the Canadian normative sample in none of the 19 monthly levels of age (Table 1). The percentile distribution of AIMS scores in our study population is displayed in Fig. 1.

In the subgroup of 345 full-term infants, assessed in terms of possible associations between socioeconomic parameters and infants' AIMS scores, no difference was revealed in the mean AIMS scores with respect to gender, birth order, paternal educational level or monthly family income by univariate analysis, whereas the effect of maternal age was of borderline significance ($p = 0.05$) (Table 2). However, significant associations were found between AIMS scores and (a) maternal educational level ($p = 0.02$) and (b) person who had the responsibility for the infants' raising on a daily basis ($p < 0.001$). Specifically, the highest mean AIMS scores were noted in infants whose mothers had post-secondary education and also in infants who were raised by grandparents or babysitters (Table 2).

When all the socioeconomic parameters studied were simultaneously included in a multiple linear regression analysis model (Table 3), the statistical significance of the univariate associations remained almost unchanged with the exception of maternal age ($p = 0.17$). One level increase of maternal educational level was associated with an increase of the infants' mean AIMS score by 2.12 points (95% CI: 0.28–3.96; $p = 0.02$), whereas being raised by grandparents/babysitters was related to higher mean AIMS scores by 8.54 points (95% CI: 5.73–11.35; $p < 0.001$) as compared to infants who were being raised by their parents.

4. Discussion

The results of this study indicate that gross motor maturity of healthy Greek full-term infants assessed by AIMS during the first

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