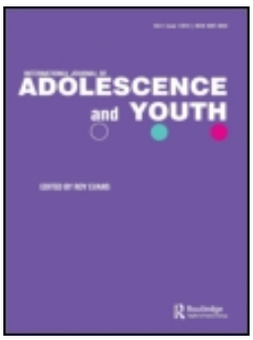

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A study on the influence of occupation on development of motor activities in children

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The study was aimed to assess the role of nutritional status and socio-economic status, body composition and occupation on motor development. The height, weight and skinfold thickness of bicep, tricep, suprailiac, subscapula and thigh of 144 boys aged 10–14 years were measured. Nutritional and socio-economic statuses were also measured. The Bruininks–Oseretsky Test of Motor Proficiency – Second Edition – Short Form was used to assess children's motor ability. Mean values of fine motor development tests of schoolboys were significantly higher than those of hotel boys and bookbinders. Schoolboys and bookbinders showed significantly higher mean values of gross motor development than those of hotel boys. Occupation itself is strongly associated with fine motor development, while it is identified as a partial determinant for gross motor development. Nutritional status and socio-economic status of surveyed boys appear to be significant predictors for their fine and gross motor development.

Keywords: occupation; nutritional status; socio-economic status; motor development; motor skill; undernutrition

Introduction

Motor development is the gradual process by which a child gains use and coordination of the large muscles of the legs, trunk and arms and the smaller muscles of the hands. Motor development includes age-related changes in posture and movements, the two basic ingredients of motor behaviour (Deurenberg, Guricci, Deurenberg-Yap, & Hautvast, 2005). Motor skill is a learned series of movements that combine to produce a smooth, efficient action. Neuromuscular development starts in embryonic stage and it continues after birth. The role of nutritional and socio-economic factors in motor development, in both prenatal and postnatal stages, has been reported by several workers (Benefice, Fouere, Maline, & Beunen, 1996; Bobbio, Morcillo, Barros, & Concalves, 2007; Booth et al., 1999; Groos, 1991). These factors may affect motor development by impairing brain growth and development (Leiva, Inzunza, Perez, & Castro, 2001) and/or by influencing the physical growth and body composition (Pollitt et al., 1994). Studies from different parts of the world have also shown that development of motor skill is closely associated with physical activity in both children and adolescent (Okely, Booth, & Patterson, 2001; Wrotniak, Epstein, Dorn, Jones, & Kondills, 2006). In other words, physical activity has been found to be an additional determinant of motor performance along with other factors. But, as the physical activity may vary with different occupational categories, the development of both fine and

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gross motor skills may be changed with occupational variations. There is no such report that clearly suggests the motor performance varies with different occupational categories. Study on the association between motor performance and occupation may provide information regarding the role of occupational factor on motor development. Therefore, the purpose of the present study was to characterise the fine and gross motor development of 10–14-year-old boys with three different occupational categories such as schoolboys, hotel boys and bookbinders, and to assess the role of nutritional and socio-economic status (SES), body composition and occupation on their motor development.

Methods and materials

Study population

A total of 144 boys (75 schoolchildren, 34 roadside hotel workers and 35 binding workers) aged 10–14 years were examined in this study. Schoolchildren were taken randomly from primary and secondary sections of a school named South Sub-Urban School, Bhawanipore, Kolkata. Data were collected after obtaining consent from parents and school authorities. Roadside hotel workers of roadside hotels were arranged from Patwar Bagan Street and Paikpara area of Kolkata. Binding workers were arranged from Rajabazar area of Kolkata. In the case of roadside hotel workers and binding workers, data were collected after obtaining consent from parents and their proprietor. Children with any systemic disease or with major surgical operations for neurological, sensory or motor problems that could influence their motor proficiency were excluded from participating in the study. The protocol and procedures employed were in accordance with the human ethical guidelines of Helsinki Declaration (Touitou, Portaluppi, Smolensky, & Rensing, 2004).

Socio-economic status

SES was measured using the updated Kuppusswami scale (Kumar, Shekhar, Kumar, & Kundu, 2007), which is based on monthly family income, parental education and parental occupation. Structured questionnaires were used to collect information on socioeconomic characteristics of subjects' families from their parents and/or school authorities.

Anthropometrics

The height and weight of each child was measured by standard techniques (Lee & Nieman, 2007). The body mass index (BMI) was also calculated. The skinfold thickness of bicep, tricep, suprailiac, subscapula and thigh were measured using a Holtains skinfold caliper with a constant spring pressure of 10 g/sq m. Three measurements of each skinfold location were taken.

Nutritional status

Both chronic and acute nutritional status was assessed by using height-for-age and weight-for-age *z*-score values of the World Health Organization (1983), respectively.

Percentage of body fat, fat mass and fat-free mass

For estimating the percentage of body fat (BF%) from the skinfold thickness, the formula developed by Slaughter et al. and cited in Cameron, Griffiths, and Wright (2004) was used. This equation is the sum of tricep skinfold (TRSF) and subscapular skinfold (SSSF) to

predict the body fat. Fat mass (FM) and fat-free mass (FFM) were calculated (Lee & Nieman, 2007). The formulae are as follows:

$$\text{BF\%} = 1.21(\text{TRSF} + \text{SSSF}) - 0.008(\text{TRSF} + \text{SSSF})^2 - 3.2$$

$$\text{FM} = (\text{BF\%}/100) \times \text{bodyweight(kg)}$$

$$\text{FFM} = \text{bodyweight(kg)} - \text{FM(kg)}$$

Test for motor performance

The Bruininks–Oseretsky Test of Motor Proficiency – Second Edition – Short Form (BOT-2) was used to assess children's motor ability (Bruininks & Bruininks, 2005). The BOT-2 is a standardised assessment of motor skill achievement commonly used in the assessment of motor abilities in children. In the present study, three items for evaluating fine motor development (Drawing lines through paths – crooked and curved, Copying a star and Copying a square) and three items for evaluating gross motor development (Transferring pennies, One-legged stationary hop and Full push-ups) were performed. In this study the cases of fine items were performed to assess the fine motor precision (Drawing lines through path) and fine motor integration (Copying a square, Copying a star), and gross items were performed to assess the manual dexterity (Transferring pennies), running speed and agility (One-legged stationary hop) and strength (Full push-ups).

Statistical analyses

Descriptive statistics such as the mean and standard error of mean for different anthropometrics, body composition parameters and BOT-2 test items (both fine and gross) were computed. Analysis of variance was performed for comparing the data of BOT-2 test items among three occupational groups followed by a least significant difference *post-hoc* test. Separate multiple regression analyses were used to examine the association between motor proficiency, nutritional status, SES, BF% and BMI using four incremental models. The outcome variables for two separate analyses were total fine and gross motor proficiency scores. First, a linear regression model was used to examine the association between occupation as the only independent variable and motor score. Next (Model 2), nutritional status was added to the model to assess its influence on the association between occupation and motor proficiency. In the third model, SES was added to Model 2. Finally, for Model 4, in order to examine the potential effect of body composition on motor proficiency, we included BF% and BMI as predictor variables. All statistical analyses were performed using SPSS software (version 11.0).

Results

Anthropometrics

Descriptive statistics of different anthropometric and body composition parameters are shown in Table 1.

Socio-economic status

About 6.67%, 92% and 1.33% schoolboys were found in lower middle, upper lower and lower socio-economic classes, respectively. All of the hotel boys and bookbinders were

Table 1. Values of different parameters in schoolboys, hotel boys and bookbinders.

Parameter	Schoolboys ($n = 75$)	Hotel boys ($n = 34$)	Bookbinders ($n = 35$)
Height	141.02 ± 1.34	141.02 ± 1.72	145.01 ± 1.67
Weight	32.11 ± 0.97	33.67 ± 0.89	33.36 ± 1.39
BMI	16.01 ± 0.34	16.88 ± 0.26	15.71 ± 0.44
BCSF	6.44 ± 0.33	6.89 ± 0.31	5.28 ± 0.37
TRSF	10.63 ± 0.49	7.46 ± 0.26	6.91 ± 0.36
SPSF	8.59 ± 0.52	6.21 ± 0.24	6.78 ± 0.46
SBSF	9.98 ± 0.61	6.84 ± 0.19	7.86 ± 0.49
THSF	15.49 ± 0.58	8.55 ± 0.25	9.48 ± 0.46
BF%	16.18 ± 0.88	12.41 ± 0.41	12.75 ± 0.73
FM	5.67 ± 0.47	4.21 ± 0.19	4.45 ± 0.45
FFM	26.44 ± 0.59	29.46 ± 0.76	28.91 ± 1.02

Data presented as mean ± standard error of the mean. BMI, body mass index; BCSF, biceps skinfold; TRSF, triceps skinfold; SPSF, suprailiac skinfold; SBSF, subscapular skinfold; THSF, thigh skinfold; BF%, percentage of body fat; FM, fat mass; FFM, fat-free mass.

Table 2. Distribution of surveyed boys in different groups of socio-economic status.

Socio-economic status	Schoolboys	Hotel boys	Bookbinders
Lower middle	5 (6.67%)	–	–
Upper lower	69 (92%)	–	–
Lower	1 (1.33%)	34 (100%)	35 (100%)

found to be in the lower socio-economic class. Thus the SES of schoolboys was found to be better than the other two groups (Table 2).

Nutritional status

About 29.33% of schoolboys were found in the moderate (−2 to −2.99 *z*-score) category of chronic undernutrition (height-for-age) compared with 5.88% and 8.57% of hotel boys and bookbinders, respectively. Similarly, a major percentage of schoolboys (26.67%) was found in the moderate (−2 to −2.99 *z*-score) category of acute undernutrition (weight-for-age) compared with 5.88% and 14.29% of hotel boys and bookbinders, respectively. Very few per cent of subjects (5.33% of schoolboys, 2.94% of hotel boys and 2.86% of bookbinders) were observed in the severe category of chronic undernutrition (Table 3).

Table 3. Nutritional status of schoolboys, hotel boys and bookbinders.

	Schoolboys		Hotel boys		Bookbinders	
z-score category	Height-for-age (%)	Weight-for-age (%)	Height-for-age (%)	Weight-for-age (%)	Height-for-age (%)	Weight-for-age (%)
≥0.99	19 (25.33)	15 (20.00)	3 (8.82)	12 (35.29)	17 (48.57)	5 (14.29)
−1 to −1.99	30 (40.00)	37 (49.33)	28 (82.35)	20 (58.82)	14 (40.00)	25 (71.43)
−2 to −2.99	22 (29.33)	20 (26.67)	2 (5.88)	2 (5.88)	3 (8.57)	5 (14.29)
≤3	4 (5.33)	3 (4.00)	1 (2.94)	0 (0.00)	1 (2.86)	0 (0.00)

Motor performances

Mean point values of individual fine tests like Copying square and Copying star, and total point score of fine tests for schoolboys were significantly higher ($p < 0.01$) than those of hotel boys and bookbinders (Table 4). Hotel boys committed a significantly ($p < 0.01$) larger number of errors in the Drawing line in crooked path item than schoolboys and bookbinders. Schoolboys showed significantly higher ($p < 0.05$) mean values for individual gross tests like Transferring pennies, One-legged stationary hop, Full push-up and total gross score than those of hotel boys. Mean values of Transferring pennies, One-legged stationary hop and total gross score for bookbinders were also significantly higher ($p < 0.001$) than those of hotel boys. The total standardised score of schoolboys was significantly higher ($p < 0.01$) than those of hotel boys and bookbinders, and that of bookbinders was significantly higher ($p < 0.001$) than hotel boys.

Regression analyses

Stepwise regression analyses showed that occupation alone (Model 1) or with nutritional status (Model 2) has significant impact ($p < 0.001$) on fine motor performance (Table 5). SES was also found to be a significant predictor for fine motor development.

Table 6 shows that, except height-for-age *z*-score and BMI, all other predictor variables such as occupation, weight-for-age *z*-score, SES and BF% have a significant contribution ($p < 0.05$) to gross motor performance.

Discussion

The results of the present study clearly suggest that occupation was found to be an influencing factor for both fine and gross motor development. But the influence of occupation seems to be different in the fine and gross motor performance. It appears that occupation itself is strongly associated with fine motor development, while it is identified as a partial determinant for gross motor development. Difference in association between occupation and fine or gross motor performances can be explained by variation of physical activities related to different occupations. Fine motor skills involve the use of very precise motor movement in order to achieve an especially delicate task, which includes ability to manipulate small objects, transfer objects from hand to hand and various hand–eye coordination tasks (Auburt, 2007). Indeed, fine motor development refers to the development of skills involving the smaller muscle groups such as muscle movements of hands and fingers. On the other hand, gross motor developments are natural type of response pattern that a child acquires with daily physical activities like locomotion, recreational activities and other non-occupational works (Auburt, 2007). The physical movements involved with occupational work can further influence the development of gross and fine motor movements.

Occupation-wise variations in both fine and gross motor performances were much pronounced in the comparative analyses of performance score of three occupational groups in different fine and gross motor items. It has been observed that the fine motor performance scores in schoolboys were better than that of other two occupational groups. The schoolboys of the present study are more likely to engage with fine motor tasks such as writing, drawing, grasping objects, reaching out to objects, releasing the objects and turning the wrist in various directions. The schoolboys are familiar in writing and drawing activities that give them more advantage to score better in fine motor performances than other two occupational groups. Schoolboys also scored better in gross motor items as they may participate more in different types of sports and game items, which lead to refine their gross motor skills that

Table 4. Fine and gross items scores and total BOT-2 scores in schoolboys, hotel boys and bookbinders.

BOT-2 test	Schoolboys	Hotel boys	Bookbinders	*F* ratio (2141)	*Post-hoc* results (LSD method)
Fine tests					
Drawing line in crooked path (number of errors)	0.62 ± 0.39	2.29 ± 0.63	0.29 ± 0.29	4.31	HB > SB** and HB > BB**
Copying square (points)	4.92 ± 0.11	4.21 ± 0.16	4.58 ± 0.21	14.46	SB > HB*** and SB > BB**
Copying star (points)	3.23 ± 0.21	0.83 ± 0.25	1.55 ± 0.32	26.13	SB > HB*** and SB > BB***
Total score of fine tests	14.99 ± 0.27	10.71 ± 0.48	12.97 ± 0.45	34.89	SB > HB***, SB > BB*** and BB > HB***
Gross tests					
Transferring pennies (number of pennies in 15 s)	15.34 ± 0.46	12.48 ± .69	15.89 ± 0.47	8.97	SB > HB*** and BB > HB***
One legged stationary hop (number of correct hops in 15 s)	36.49 ± 0.56	20.02 ± 0.51	34.29 ± 0.58	193.21	SB > HB***, SB > BB** and BB > HB***
Full push-up (number of correct push-up in 30 s)	7.87 ± 0.57	6.01 ± 0.39	7.69 ± 0.31	2.94	SB > HB*
Total score of gross tests	17.89 ± 0.31	13.59 ± 0.44	17.89 ± 0.24	42.21	SB > HB*** and BB > HB***
Total standardised score	32.89 ± 0.43	24.29 ± 0.76	30.86 ± 0.56	60.31	SB > HB***, SB > BB** and BB > HB***

Data presented as mean ± standard error of the mean. BB, bookbinders; HB, hotel boys, LSD, least significant difference; SB, schoolboys. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 5. Stepwise regression models for the association between fine motor performance and nutritional status (HAZ, WAZ), SES and body composition (BMI and BF%).

	Beta (95% confidence interval)				
	Unstandardised	Standardised	p value	R^2	Changes in R^2 from previous model
Model 1					
Occupation	1.32	0.36	0.001	0.129	0.129
Model 2					
Occupation	1.427	0.285	0.001	0.198	0.068
HAZ	0.994	0.253	0.003		
WAZ	0.986	0.229	0.006		
Model 3					
Occupation	0.588	0.16	0.221	0.224	0.026
HAZ	0.894	0.227	0.008		
WAZ	1.074	0.25	0.003		
SES	0.355	0.276	0.032		
Model 4					
Occupation	0.49	0.133	0.311	0.241	0.017
HAZ	0.737	0.187	0.066		
WAZ	0.953	0.221	0.097		
SES	0.32	0.249	0.045		
BMI	0.147	0.124	0.375		
BF%	0.218	0.176	0.081		

Note: Dependent variable = fine motor score. BF%, percentage of body fat; BMI, body mass index; HAZ, height-for-age z-score; SES, socio-economic status; WAZ, weight-for-age z-score.

Table 6. Stepwise regression models for the association between gross motor performance and nutritional status (HAZ, WAZ), SES and body composition (BMI and BF%).

	Beta (95% confidence interval)				
	Unstandardised	Standardised	p value	R^2	Changes in R^2 from previous model
Model 1					
Occupation	0.415	0.115	0.17	0.013	0.013
Model 2					
Occupation	0.456	0.127	0.125	0.11	0.97
HAZ	0.877	0.227	0.012		
WAZ	1.369	0.324	0.001		
Model 3					
Occupation	1.174	0.326	0.014	0.213	0.103
HAZ	0.683	0.177	0.039		
WAZ	1.54	0.365	0.001		
SES	0.689	0.546	0.001		
Model 4					
Occupation	1.342	0.372	0.005	0.256	0.043
HAZ	0.345	0.089	0.374		
WAZ	1.142	0.27	0.041		
SES	0.646	0.512	0.001		
BMI	0.292	0.251	0.07		
BF%	0.131	0.273	0.007		

Note: Dependent variable = gross motor score. BF%, percentage of body fat; BMI, body mass index; HAZ, height-for-age z-score; SES, socio-economic status; WAZ, weight-for-age z-score.

may make the occupational difference in gross motor performances more prominent. However, gross motor performance of school boys was comparable with that of bookbinders. Bookbinders of the present study are mainly involved in unskilled work in the binding factory such as carrying of load, punching boards, preparation of gum paste and helping skilled workers. All these activities mostly required gross muscular movements and very little fine muscular activities. Regular participation of bookbinders in their habitual physical movements helped them to perform better in gross motor performance. It is widely believed that the habitual physical activities and motor skills are strongly related to each other in childhood and adolescence (McKenzie, Sallis, & Broyles, 2004; Okely et al., 2007). In addition, as the schoolboys belong to a comparatively higher SES than the subjects of other two groups, this might also be a contributing factor for their overall better motor performance. This study provides support for the relationship between motor proficiency and occupation. However, there are a few methodological points to consider in interpreting these results. As the study was cross-sectional, the direction and impact of the relationship between motor proficiency and occupation cannot be determined.

Nutritional status and SES of the surveyed boys appear to be significant predictors for both fine and gross motor development. Similar observations have been reported by other research workers in children of different countries (Bobbio et al., 2007; Chowdhury, Wrotniak, & Ghosh, 2010; Pollitt et al., 1994;). Nutritional status may alter the learning process by influencing brain development and physical growth, and accordingly modify the movement proficiency of the children by adjusting the strength, power, coordination and perception (Stanfield, 1993; Zernicke & Schneider, 1993). SES is related to living conditions that may contribute to motor development by modifying the opportunities for social contacts and learning.

Therefore, this study indicates that occupation itself is strongly associated with fine motor development, while it is identified as a partial determinant for gross motor development. Nutritional status and SES of surveyed boys appear to be significant predictors for their fine and gross motor development.

Notes on contributors

Satabdi Ghosh passed an MSc in human physiology in 2010 and has started working on neuromuscular development under the guidance of Tusharkanti Ghosh.

Sutanu Dutta Chowdhury is a PhD student of the Department of Physiology working under the guidance of Tusharkanti Ghosh on the nutritional status of Santal children.

Ananga Mohan Chandra is a senior professor of the Department of Physiology and has guided many students for PhD degrees. He has expertise in the field of ergonomics and is actively involved with this research work.

Tusharkanti Ghosh is at present working as a professor in physiology at the University of Calcutta. He earned his MSc and PhD from the University of Calcutta and thereafter joined the Department of Pharmacology, Howard University, USA, as a postdoctoral research fellow. He has been teaching physiology in many undergraduate and postgraduate departments of different universities of India for more than 32 years. His current research interests include neuroimmunemodulation, cognitive and motor development in children, community health and nutrition, and physiology in hypobaric environment.

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