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A contrast of youngsters' fitness in the hilly and Terai area of Chitwan district of Nepal

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Abstract
The data from this paper was gathered from a larger cross-sectional study examining children's physical activity participation in the Hilly Area and the Terai Area of Chitwan district. The purpose of this study was to carry out a battery of health and fitness tests with children in both areas to examine possible differences in various aspects of fitness or health by area. Heart rate recovery, flexibility, body fat, hand grip strength, upper body strength, explosive strength and agility were all measured using youth fitness tests endorsed by Jha Physical Fitness Test Battery with 59 boys and 57 girls across both areas. There were no statistically significant differences in both groups of children in hand grip strength, flexibility and agility. Statistically significant differences were noted between both groups of children in explosive strength, upper body strength and measured body fat percentage. Overall the study showed mixed results that may indicate area of residence influences aspects of fitness or activity. Further study is recommended to assess whether physical activity could play a role in the associated fitness characteristics.

Keywords: children, fitness tests, health related fitness, physical activity, young people

1. Introduction
Fitness testing has been commonly used as an assessment of young people's fitness both in schools and in public health (Cale & Harris, 2009) [5]. The health related components of one's fitness cardio-vascular, body composition, flexibility, muscle endurance, or strength) are tested because of their relation to health/disease outcomes in later life (Cale & Harris, 2005) [6]. It could be argued that among other factors, a young person's fitness may determine how much physical activity they actually participate in. In a pediatric population Cale & Harris (2005) [6] point out that circumstances such as biological, maturity, hereditary amongst others contribute to fitness level. Some of the difficulties of finding a relationship between fitness and PA lie in the sporadic nature of children's physical activity behavior (Bailey et al., 1995) [2]. Nevertheless, a weak but positive association was found between children's aerobic fitness and their physical activities levels by Dencker et al. (2007) [8] in their study of 248 children from 8 to 11 years. Although at present evidence seems fragile that components of fitness or activity predict overweight in young people (Rauner, Mess, & Wolf, 2013) [13] more data regarding the influence of fitness on a healthy cardio-vascular disease (CVD) risk profile and future health is emerging. Furthermore, it has been noted that youth fitness tracks into adulthood, Welk & Blair (2005) [10] and Froberg & Anderson (2005) [8], and there is a strong evidence base of fitness having a "protective effect" to health on overweight status in adults (Barlow, Kohl, Gibbons, & Blair, 1995; Riddoch et al., 2009; Thorp, Owen, Nuehuas, & Dunstan, 2011) [2, 3]. Although many factors contribute to a young person's physical fitness, Boreham & Riddoch (2001) [4] have concluded that probability suggests that the ultimate benefit to adult health would be to guarantee sufficient fitness and activity in young people.
There is evidence in the existing literature that would imply that health and life expectancy differ according to the geographical location. (Black, Morris, Smith, & Townsend, 1980; Davey Smith, Bart- ley, & Blane, 1990 [7]; Davey Smith & Egger, 1993; Office for National Statistics, 2013). It is also well documented that physical activities and fitness in adults have a positive effect on health therefore increasing life expectancy (Blair & La- Monte, 2005; Duncan et al., 2005) [10]. While it has been noted that children's fitness could differ according to geo- graphical area and is worthy of further investigation (Dollman, Norton, & Tucker, 2002) [9], few data are available that examine whether fitness levels differ by location in Chitwan in adults or children. Thus, the main aim of this study was to explore whether children in the Hilly Area of Chitwan displayed any different characteristics, in the aspects of fitness tested, compared with children of the same age group in the Terai Area of Chitwan.

2. Methods
2.1 Participants
Four comprehensive secondary schools were matched according to characteristics described in the District Education Office. Two were in the Hilly Area of Chitwan, two in the Terai Area. The schools were selected on the basis of a close match in: examination results, percentage of children on free school meals and percentage of children with special educational needs (SEN).

2.2 Measures
The tests used were taken from Jha Physical Fitness Test Battery of fitness tests.

Table 1: Demographic characteristics of children in fitness test study by area.

Characteristic	Area						
	Hilly Area (n = 57)		Terai Area (n =59)		Absolute difference	Odds ratio (95% CI)	*P*-value
	n	%	n	%			
Gender (male)	27	47.40%	32	54.20%	-6.80%	1.3 (0.64 to 2.7)	0.46

Note: *P*-value from chi squared test.

Table 2: Demographic characteristics of children in fitness test study by area

Characteristic	Area								
	Hilly Area (n = 57)			Terai Area (n = 57*)			Un-adjusted mean difference	(95% CI)	*P*-value
	n	Mean	SD	n	Mean	SD			
Mean age	57	11.6	0.5	57	11.7	0.5	−0.12	(−0.30 to −0.05)	0.17

Note: *P*-value from independent sample t-test; * of 59, two children failed to record their age.

An record sheet was provided for the children to record their fitness scores on and the children were given a tutorial immediately prior to testing on how to record their scores. The fitness measures have been described more fully (Boyle, 2009), however a brief description follows:

Harvard step test: a sub-maximal fitness test which predicts cardio-vascular fitness (endurance) from the rise of heart rate during moderate exercise, rather than exercise to exertion (Brouha, Health, & Graybiel, 1943). Participants stepped on and off a bench for five minutes and then measured and recorded their own heart rate at one minute intervals for three minutes after the exercise (for 30 seconds, multiplied by 2 by the researcher on collection). The three pulse readings were combined using the following equation:

Heart rate group score =

$$30000/ (\text{pulse } 1+ \text{pulse } 2+ \text{pulse } 3) \quad (1)$$

This gave a score which could be compared to a level from poor to excellent (1).

Sit and reach test: to measure flexibility in the lower back and hips. Participants sat on the floor with straight legs, leant forward and the distance they could reach past their toes in cm was recorded.

Skin fold thickness: to assess body fat. The thickness of skin in mm was taken with a Harpenden skin fold caliper on the back of the upper arm (tricep) and back of the same side lower leg (calf). Slaughter et al. (1988) equation was used to determine body fat as follows;

boys, % body fat = 0.735(triceps+calf)+1.0
girls, % body fat = 0.610(triceps+calf)+5.1

Hand grip strength: to measure overall strength. Participants were asked to grip a hand dynamometer which gave a measure of their strength in kg.

Modified pull-up: to measure upper body strength. Participants performed as many pull-ups as possible on a bar positioned on a special stand so that the child's feet never left the floor.

Standing broad jump: to measure explosive strength. Participants were asked to jump as great a distance as they could (measured in cm) taking off from two feet and landing on two feet.

Speed bounce test: to measure agility, muscular endurance and speed in the legs. Participants jumped over a small barrier as many times as possible in 15 seconds.

2.3 Procedures

The participating schools were part of a cross-sectional study examining PA, diet and quality of life. Local Education Authority was consulted in order to gain initial contact with secondary schools involved. Consultation with the head teachers of the secondary schools followed this. Initially the study details were circulated in a school, which every parent received, at each school. After this process the whole school's population were given an information letter to take home with a consent slip to be returned by a parent or guardian.

As the fitness testing involved seven tests and the children had a limited amount of time within their Physical education lesson, PE teachers helped with the organisation and recording of test results. Before the testing took place the teachers involved were briefed. As most PE teachers are familiar with the equipment that was used this briefing was straightforward. The children involved in the fitness tests were told of their result at the conclusion of each test and supervised to record their result on a pre-prepared result sheet. A brief procedure of how children were managed during the fitness testing has been provided elsewhere.

The original study population (n = 858) was drawn from four schools across year groups 7 - 10, ages 11 - 15 years. From this population a random selection of year 7 pupils (aged 11 and 12 years) (boys and girls) was taken within each school to complete seven basic fitness tests. In total there were 57 pupils (n = 27 boys, 30 girls) who were tested Hilly Area and 59 pupils (n = 32 boys, 27 girls) who were tested in Terai . Testing was arranged to coincide with a time in all four schools when year 7 pupils were scheduled for a PE lesson. The sample was randomly chosen, every other child on the boys' register and every other child on the girls' register. These pupils completed the fitness tests while the rest of their class took part in their normal PE lesson. The same sampling procedure was followed at all four schools involved. At this stage the children selected were again given the option of withdrawing. The results of these measures were compared cross-sectional within the HR and TR schools and also against results gained in other studies using the same aged children and test measures.

2.4 Data analyses

Statistical methods were used to analyse the fitness testing outcomes. Continuous fitness testing outcomes (skin fold thickness, sit and reach score, hand grip strength, modified pull-ups, standing broad jump, speed bounce hurdles) were compared between areas using a two independent samples *t*-test. A 95% confidence interval for the mean difference in outcomes between the areas was also calculated. A multiple linear regression model was used to adjust the between area comparison of fitness test outcomes, for the potential confounding factors of age and gender.

Binary fitness testing outcomes (optimal body fat for gender [using Slaughter et al., 1988] and above average heart rate score) were compared between the areas with a chi squared test. An odds ratio and associated 95% confidence interval for the contrast between areas was also calculated. A multiple logistic regression model was used to adjust the between area comparison of the binary fitness test outcomes, for the potential confounding factors of age and gender.

3. Results

The demographic characteristics tables (Table 1 and Table 2) showed just over half the participants in the Terai Area were boys (54.2%) and just under half (47.4%) in the Hilly Area were boys. The mean age of the participants was 11.6 years and 11.7 years (SD 0.5) in the HR and TR, respectively. There were no significant differences in the respondents for each area by age or gender.

Table 3 shows there were no statistically significant differences between the two groups of children in the sit and reach test, the hand grip strength test and the speed bounce hurdle test. When a multiple linear regression model was applied, to adjust the comparison between the groups for age and gender, there was also no significant difference between the children in the HR and those in the TR. The mean scores in the sum of skin fold measured, number of modified pull-ups and length of standing broad jump all showed significant differences between the HR children and the TR, with the HR group reporting a better standing broad jump score, jumping a mean of 0.3 m further (95% CI 0.2 to 0.4; $P < 0.0001$). The TR group reported a greater number of modified pull-ups, a mean of 1.01 modified pull-ups more (95% CI −1.3 to −0.57; $P < 0.0001$) and a lower body fat, a mean of 5.1 mm less the HR children (95% CI 2.7 to 7.4). These differences remained after adjusting for covariates.

Table 4 shows the proportion of boys and girls with an optimal body fat score. An optimal body fat by sum of tricep and calf skin fold for boys of this age would be 11 - 25 mm and girls 17 - 30 mm (Slaughter et al., 1988). In the HR 49.1% had an optimal body fat score compared with 75.4% in the TR, a significant difference of −26.3% with an OR of 0.3 (95% CI 0.1 to 0.7; $P = 0.004$). When a multiple logistic regression was applied, adjusting analysis for area (HR/TR), age and gender, area (TR) was found to have a significant positive relationship on proportion of children with an optimal body fat; OR 0.3 (95% CI 0.1 to 0.7; $P = 0.004$).

The proportion of pupils who achieved above an average heart rate group score was 87.7% in the HR compared with 91.5% in the TR, a non-significant difference (see Table 4). When a multiple logistic regression was applied, adjusting analysis for area (HR/TR), age and gender no significant relationship was found on the percentage of pupils who achieved at least above average heart rate group score and area (see Table 4).

The results of the eight outcomes of fitness testing can be seen in Table 3 and Table 4.

Table 3: Main outcomes of Terai Area and Hilly Area fitness testing (continuous data)

Characteristic	Hilly Area				Terai Area			Area *Mean (95% CI) difference	*P*-value difference ~Mean (95% CI)		*P*-value
	n	Mean		SD	n	Mean	SD				
Skin fold sum mm (sum of calf and tricep)	57	27.8	6.2	57	22.7	6.2	5.2	(2.9 to 7.5)	<0.0001	5.1	(2.7 to 7.4) <0.0001
Sit and reach test (cm)	57	37.4	6.6	58	38.1	6.6	−0.72	(−3.2 to 1.7)	0.56	−0.79	(−3.3 to −1.7) 0.53
Hand grip strength (kg)	57	18.1	4.7	59	16.5	5.1	1.6	(−0.22 to 3.4)	0.09	1.6	(0.18 to 3.4) 0.08
Modified pull-up (number completed without rest)	57	1.2	0.94	59	2.17	1.2	−1.01	(−1.4 to −0.6)	<0.0001	−0.94	(−1.3 to −0.57) <0.0001
Standing broad jump (m) Speed bounce hurdle	57	1.4	0.26	59	1.1	0.26	0.3	(0.2 to 0.4)	<0.0001	0.3	(0.2 to 0.4) <0.0001
(number completed in 15 seconds)	57	27.7	5.8	59	26	4.8	1.07	(−0.9 to 3.05)	0.29	1.5	(−0.38 to 3.5) 0.11

Note: *Un-adjusted simple analysis (*t*-test); ~Adjusted analysis for age, gender, area (HR/TR).

Table 4: Main outcomes of Terai Area and Hilly Area fitness test (binary data)

Characteristic	Hilly Area		Terai Area		*Difference Odds ratio (95% CI)	*P*-value	Adjusted difference odds ratio	(95% CI)	*P*-value
	n	%	n	%					
~Heart rate group score 87.70% (achieving above average)- Boy or girl optiaml body	50/57	54/59	91.50%	−3.80%	0.7 (0.2 to 2.2)	0.5	0.6	(0.2 to 2.2)	0.46
fat (skin fold, boys 11 - 25 49.10% mm, girls 17 - 30 mm)	28/57	43/57	75.40%	−26.30%	0.3 (0.1 to 0.7)	0.004	0.3	(0.1 to 0.7)	0.004
#Girls optimal body fat 56.70% (17 - 30 mm)	17/30	23/26	88.50%	−31.80%	0.2 (0.04 to 0.69)	0.009	0.2	(0.04 to 0.7)	0.017
#Boys optimal body fat 11 out of 27 40.70% (11 - 25 mm body fat)	20/31	20/31	64.50%	−23.80%	0.4 (0.1 to 1.1)	0.07	0.4	(0.1 to 1.1)	0.08

Note: *Simple analysis (chi squared); ~Adjusted analysis for age, gender; #Adjusted for age only in regression model.

4. Discussion

The main findings of this study indicate significantly more children in the TR had optimal body fat than children in the HR. The HR children had a significantly longer standing broad jump than the TR. However, the TR children demonstrated greater upper body strength in the modified pull-up test than the HR children. The findings of the study also show no relationship between area in which the children live and tests for heart rate recovery, hand grip strength, flexibility (lower back and hamstrings) and speed and agility.

The difference in body fat, standing broad jump and modified pull-up scores between these HR and TR children provides perhaps some initial evidence of differences in dimensions of fitness in children in different areas of Chit wan.

Age and gender of the children were not significantly different. At this age (boys = 11.7 years, girls = 11.6 years) both girls and boys would be at different stages of maturity. Girls tend to mature earlier, and stop growing earlier; having their adolescent growth spurt approximately 12 years old (early maturing girls may have had it by this age) compared to boys who have it around 14 years old. Strength, motor performance and other physical tests would be influenced by body composition and physique. From the test measures used there is no way of knowing how physically mature the children taking part were, or if there was a mix of more physically mature children in one area

compared to another. Some boys and girls go on growing into their early twenties and motivation, habitual physical activity, environment, or attitude could all add to the resulting performance (Malina et al., 2004) [12]. Nevertheless, the maturity of the participants could arguably have had some implication on the test results. The only demographic information collected from the children was their gender and age. Therefore, the influence of socioeconomic status or ethnicity, which both have an effect on activity, if not fitness could not be taken into account in the analysis (Khunti et al., 2007; Van Sluijs, McMinn, & Griffin, 2007) [11]. Comparison of these fitness test study results to other research in the UK or across Europe should be viewed with caution; although the same tests were used in other research studies, differences in measuring equipment and environment or conditions of tests may have existed. Indeed the results of some of the test measures may have been influenced by lack of/motivation of the pupils on the day of the tests. Slight human errors could have been recorded in the measurements of each of the fitness tests, as some of the tests were supervised and recorded by the experienced PE teachers on the day of the tests.

5. Conclusion

In this sample children in the TR of Chit wan had less body fat percentage and showed greater upper body strength than children in the HR, while children in the HR demonstrated greater explosive strength than those in the TR. Overall the results of these tests were somewhat mixed. However, if we are to assume that fitness levels could be a factor to account for the inequalities in health in different areas of the country. The variation found in these fitness test markers could indicate a difference on a broader scale. Although secondary school national curricular PE is compulsory across the country there can be differences in sports or activities employed in its delivery per school. There may even be the possibility of variations in habitual physical activity or the favoured games and physical activities practised by children in different area. These tentative results could be an indication that area of residence should be accounted for when implementing physical activity interventions. Further investigation is needed to examine potential differences in fitness test data and their relationship to other important factors (hereditary, physical activity level, socio-economic status, ethnicity and motivation, for example) across several Areas in Chit wan as well as Nepal.

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