Longitudinal Development And Tracking Of Risk Indicators For Cardiovascular Diseases Of Rural South African Children: The Ellisras Longitudinal Growth And Health Study.

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Abstract

INTRODUCTION
Non-communicable diseases (NCD) are major public health problems today. The Global Burden of Diseases Study predicted that there would be a 55% rise in disability adjusted life years (DALYs) attributed to cardiovascular diseases (CVD) between 1990 and 2020 in developing countries [Murray and Lopez., 1996]. It was also projected that 6.4 million deaths would occur due to CVD in these countries in the ages below 69 years [Murray and Lopez, 1996]. It is also known from prospective studies that risk factors for NCD starts early in life and increases morbidity and mortality in adulthood [Kemper et al., 2002; Twisk et al., 2001]. It has been suggested that childhood and adolescent periods are sensitive for the development of risk factors for NCD [Kemper et al., 2002; Twisk et al., 2001; Dietz, 1994; Van Lenthe et al, 1998]. Data from different developed countries demonstrated that the prevalence of pediatric hypertension ranges between 3 and 11% and is three times more frequent in obese than in normal weight children [Twisk et al., 2001; Rosner et al., 2000]. However, due to limited availability of longitudinal studies and the emerging epidemiological transition of NCD in the developing countries, the development of CVD risk factors from childhood into adolescent remain to be explored.

The transition of NCD from being a disease of the wealthy to the one of the poor has been documented in the United Kingdom, South Africa and the USA [Sorof et al., 2004; Brashaw et al., 2002; Monyeki et al., 2000]. For example, NCD was relatively rare in the African-American community in the 1960s, but now their incidence equals or exceeds that in the white population of the United States [Reddy et al., 2003]. A similar progression is prevalent in South Africa [Reddy and Yusuf, 1998; Marciano et al., 1999]. Furthermore, it needs to be born in mind that in developing countries, where the epidemiological transition has advanced fairly rapidly, there appears to be a progressive reversal of the social gradient with the poor becoming the most vulnerable victims [Reddy and Yusuf, 1998] of which rural South African populations are no exceptions.

The development of CVD appears to be occurring at a faster rate in the developing countries than occurred in the developed countries [Marciano et al., 1999; Monyeki et al., 1999; 2006]. To date the peak prevalence of CVD is found in the economically active segment of the population of developing countries as opposed to peaking in the older people as occurred in the developed countries [Marciano et al., 1999; Van Lenthe et al., 1998; Monyeki et al., 1999; 2006; Rosner et al., 2000]. Longitudinal observation of CVD risk factors throughout childhood to adolescence will shed more light onto the epidemiological transition and the development of these cardiovascular risk factors in developing countries. The aim of this study therefore, was to investigate the development of CVD risk factors of Ellisras rural children from infancy to adolescence over a five- year period and to assess the degree of tracking during this time to the selected CVD risk factors.

Method
Geographical area
Ellisras is a deep rural area situated within the north-western area of the Limpopo Province, South Africa. The population of about 50 000 people resides in 42 settlements [Sidirooulos et al., 1996]. These villages are approximately 70 km from the Ellisras town (23° 40S 27° 44W), now known as Lephalale, which is adjacent to the Botswana border. The Iscor coal mine and Matimba electricity power station are the major sources of employment for many of the Ellisras residents. The remaining workforce is involved in subsistence farming and cattle rearing, while a minority is in education and the civil service. Unemployment, poverty and low life expectancy seem to play a significant role in the rural South African population of which the Ellisras rural people are no exception [Bradshaw and Steyn, 2001; Statistics South Africa, 2002].

Sample
The Ellisras Longitudinal Growth and Health Study (ELS) initially followed a cluster sampling method [Monyeki et al, 1999;2006]. In brief, the study was undertaken at 22 schools (10 pre-school and 12 primary schools) randomly selected from 68 schools within the Ellisras area. Birth records were obtained from the school admission register through the assistance of principals in each school. Only those records that were verified against health clinic records were used to...
determine the ages of potential participants. Each of the 22 selected schools was assigned a grade with the expectation that most of the children in a particular age category (i.e. 3, 4, 9, 10) would be found in that grade.

For the purpose of this analysis data collected in November 1999, November 2000, May 2001, May 2002 and May 2003 would be included in the analysis. A total of 2021 (484 preschool children mean age 7.5 years SD= 0.97 and 1537 primary school children mean age 11.0 years SD=1.12) at baseline were followed from November 1999 to May 2003 with measurements collected once yearly. On average 1.05% of participants were permanently lost due to them passing away and 11.47 % subjects lost due to teenage pregnancy, illness, migration to urban areas, school dropout were temporary as they rejoined the study thereafter. A total of 1748 subjects (478 preschool children mean age 10.9 years SD= 0.96 and 1270 primary school children mean age 14.4 years SD= 1.08) were enrolled in the study in May 2003.

**Blood pressure (BP)**

Using an electronic Micronta monitoring kit, at least three BP (systolic and diastolic) readings were taken after the child had been seated for 5 minutes or longer [National high blood pressure education program (NHBPEP) working group on hypertension control in children and adolescents, 1996]. The bladder of the device contains an electronic infrasonic transducer that monitors the BP and pulse rate, displaying these concurrently on the screen. This versatile instrument has been designed for research and clinical purposes. In a pilot study, conducted before each survey a high correlation (r between 0.89 and 0.93) was found between the readings taken with the automated device and those taken with a conventional mercury sphygmomanometer.

**Anthropometry**

All children underwent anthropometric measurements suggested by the International Society for the Advancement of Kinanthropometry (ISAK) [Norton and Olds, 1996]. Skinfolds measurements (biceps, triceps, subscapular, suprailiac) were measured using a Harpenden (John Bull) skinfold calipers with inter-jaw pressure of 10g/mm2 surface jaw face area for skinfolds measurements to the last completed 0.1mm was used. Body mass was measured on an electronic scale to the nearest 0.1 kg, and a Martin anthropometer was used to measure height to the nearest 0.1 cm. From height and body mass the body mass index (BMI) (kg/m2) was calculated. Waist and hip girth were measured in centimeters with a flexible steel tape.

**Maturity**

The maturation assessment was included in the anthropometric survey of May 2001 and 2003 for all the children who were part of the ELS and the May 2003 assessment was included in the analysis. Breast development and genital/pubic hair development stage was assessed by visual inspection using Tanner rating scale pictures ranging from 1 (no development) to 5 (matured stage) [Tanner, 1962]. To avoid embarrassment, older children were provided with a separate private space to complete the self assessment. Once completed, the self assessment was verified by visual inspection at the "skinfold measurements" station. In instances where the average breast score was between two breast stages, the breast stage was rounded down because the higher breast stage has not been achieved. The palpation of the breast which is the superior method to assess breast development was not possible in this study because it was conducted in a class room as it was included in the "skinfold measurements" station of the anthropometric survey. The qualitative Tanner score was converted into a quantitative variables (pubertal stage by Tanner Scale of both the sexual organ and the breast development): T1=0, T2=0, T3=1, T4=2, T5=3.

**Quality control**

In this study it was possible to train team members in accordance with the standard procedures of the International Society for the Advancement of Kinanthropometry (ISAK) to have Technical Error of Measurements (TEMs) that are within the acceptable standards [Norton and Olds, 1996]. In all the five surveys (November 1999 to May 2003) the absolute and relative values for intra-tester and inter tester technical error of measurements for weight ranges from 0.12 (0.15%) to 0.31kg (0.36%) and 0.22cm (0.12%) to 0.43 (0.32%) for height and girth measurements range from 0-3.4 cm (0-4%) while for skinfolds measurements ranged from 0.2 to 6mm (0.4 to 6.8%) each year.

Maturational status was assessed by well trained field workers stationed at the "skinfold measurements" station. The intra- and inter- tester reliability conducted on 20 subjects (10 boys and 10 girls) who were not part of the survey was 100% in agreement on pubic hair and 92% on breast development.

**Ethics**

Medical students from Vrije University, Amsterdam included the BP parameter in the ongoing anthropometric measurements of the ELS. The Ethics Committee of the University of Limpopo granted ethical approval prior to the survey, and the parents or guardians provided informed consent.

**Statistical analysis**

Descriptive statistics of the development over time of blood pressure (systolic and diastolic), absolute body size (height, weight, BMI, skinfold thickness, sum of four skinfolds, waist and hip girth and waist to hip ratio) were reported. The non parametric t-test was applied to test the significance level between sexes over time.

All subjects were classified as overweight and obese according to the Cole et al. [2000] cut-off point. The international cut off points for thinness (grade one, two and three) by sex for exact ages defined to pass through BMI of 16, 17 and 18 kg/m2 were used [Cole et al., 2007]. The cut off point used for waist to hip ratio and waist girth was above 90th percentiles by age and sex specific [Maffeis et al., 2001]. Chi-square test was used to compare two or more sets of nominal data that have been arranged into categories by frequency counts of large samples, while the Fisher’s exact test was used when the expected cell frequencies were small (less than five) [Lauer and Clarke, 1989; Altman, 1991].
Partial correlation coefficients controlled for maturation and age were calculated to assess the association between the first BP and absolute body size measurements and the follow-up measurements for boys and girls separately. Linear regression model was used to assess the relationship between BP and absolute body size at the first measurements and the follow-up measurements adjusted for age and maturation for boys and girls separately.

A longitudinal tracking (Generalized Estimating Equation (GEE)) technique which measures the association between an indicator at the first period of measurements and the same indicator at all other periods of measurements were used with maturation and age being included in the model [Zeger and Liang, 1986; Twisk et al., 1997; Lipsitz et al., 1991]. Tracking was assessed by calculating odds ratios and 95% confidence interval for subjects “at risk of overweight and thinness (severe, moderate and mild)” at the initial measurements in order to maintained “at risk of their position” at the follow-up measurements using the GEE [Zeger and Liang , 1986; Twisk et al., 1997; Lipsitz et al., 1991]. All the statistical analyses were done using the Statistical Package for the Social Sciences (SPSS) and the STATA program.

RESULTS

To examine the effect caused by subjects who were absent, we compared BP and anthropometric measurements of the subjects who were absent with the follow-up subjects during each period of measurements. There was no selective drop-out regarding any of the outcome variables in the study.

Figure 1 (a-c) presents the development over time of the median and inter quartile of BP and BMI of Ellisras rural preschool and primary school children. Preschool girls show a significant high median SBP (p<0.05) than boys at the mean ages of 8.5 and 9.0 years (Fig 1a,b). Median BMI of primary school children exhibited an increase with increasing mean age. Primary school girls showed a significant (p<0.05) higher median SBP and DBP (p<0.05) than boys at the mean ages of 12.5 to 14.4 years (Figure 1c). Boys showed a significant (P <0.05) high mean waist to hip ratio than girls throughout the age range for both preschool and primary school children (Figure 1d).

![Figure 1a,b. Development of the median systolic blood pressure and the inter-quartiles (25; 75) for Ellisras rural preschool and primary school children.](image1)

![Figure 1a,b. Development of the median diastolic blood pressure and the inter-quartiles (25; 75) for Ellisras rural preschool and primary school children.](image2)
Table 1 shows the development over time of the prevalence of cardiovascular risk factors of Ellisras rural children. The prevalence of overweight ranged from 0.9% to 2.2% for preschool children and 0.6% to 13.7% for primary school children over time. The prevalence of hypertension ranged from 0 to 2.2% over time with no significant association between boys and girls in each period of measurement. It was clear that thinness was a much greater public health problem than overweight in the Ellisras population. The degree of thinness ranged from 4.7 to 41.3% for preschool children and 8.6 to 41.4% for primary school children over time.

**Figura 1c.** Development of the median body mass index and the inter-quartiles (25; 75) for Ellisras rural preschool and primary school children.

**Figura 1d.** Boys showed a significant (P<0.05) high mean waist to hip ratio than girls throughout the age range for both preschool and primary school children.

### Table 1: Development of cardiovascular risk factors over time for Ellisras rural children

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Boys</th>
<th>Girls</th>
<th>Mean Age (years)</th>
<th>CBW (cm)</th>
<th>Heart Rate (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-school</td>
<td></td>
<td></td>
<td>7-12</td>
<td>0.5-2.5</td>
<td>0.6-13.7</td>
</tr>
<tr>
<td>Primary school</td>
<td></td>
<td></td>
<td>12-14</td>
<td>0.5-2.5</td>
<td>0.6-13.7</td>
</tr>
</tbody>
</table>

- **Overweight**: Range from 0.5 to 2.5% for preschool children and 0.6 to 13.7% for primary school children over time.
- **Hypertension**: Range from 0 to 2.2% over time with no significant association between boys and girls in each period of measurement.
- **Thinness**: Degree ranging from 4.7 to 41.3% for preschool children and 8.6 to 41.4% for primary school children over time.

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*Hypertension: the occurrence of systolic or diastolic BP levels greater than the 95th percentile of height and sex adjusted reference levels was used (NHBDPEP, 1996)

*Obesity: the international recommended cut-off points for BMI in children were used (Cole et al., 2000)

*Waist girth: and Waist to hip ratio above the 90th percentiles (Maffett et al., 2003)
Table 2 exhibits the odds ratio (OR) and 95% confidence interval (CI) for the subjects at high risk of cardiovascular risk factors for preschool and primary Ellirias rural children. The significant (p<0.005) odds ratios for hypertension was 2.69 95% CI 2.53 to 2.89 for primary school boys and 2.72 95% CI 2.61 to 2.80 for primary school girls while for overweight ranged from 2.03 95%CI 1.79 to 2.32 for preschool children and 1.89 95%CI 1.75 to 2.08 for primary school children (Table 2). The odds ratio for thinness ranged from 1.34 95%CI 1.26 to 1.43 to 1.68 95%CI 1.57 to 1.80 for both preschool children and 1.45 95%CI 1.41 to 1.51 to 1.95 95%CI 1.82 to 1.97 for primary school children.

Table 3 shows a specific tracking coefficient (partial correlation coefficient controlled for age and maturation) between the values at the first measurements and the subsequent measurements and the stability coefficient derived from GEE for cardiovascular risk factors of both preschool and primary school children throughout the period of measurements. The longitudinal tracking coefficient derived from GEE for cardiovascular risk factors ranged from $B=0.67$ (95%CI 0.62 to 0.72) to $B=0.98$ (95%CI 0.93 to 1.02) for preschool children. The longitudinal tracking coefficient estimated from the GEE was high for both preschool and primary school children (Table 3).

Table 4 and 5 shows regression coefficient and 95% confidence interval in the association of the initial cardiovascular risk factors for pre-school and primary school children measured from November 1999 to May 2003 (*= p<0.05).

### Table 1

<table>
<thead>
<tr>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preschool Children</td>
<td>Primary school children</td>
</tr>
<tr>
<td><strong>%</strong></td>
<td>OR</td>
</tr>
<tr>
<td><strong>High Systolic</strong></td>
<td>4.4 (8)</td>
</tr>
<tr>
<td><strong>High Diastolic</strong></td>
<td>4.4 (8)</td>
</tr>
<tr>
<td><strong>Hypertension</strong></td>
<td>1.0 (2)</td>
</tr>
<tr>
<td><strong>Overweight</strong></td>
<td>0.9 (2)</td>
</tr>
<tr>
<td><strong>Overweight</strong></td>
<td>0.9 (2)</td>
</tr>
<tr>
<td><strong>Sever Thinness</strong></td>
<td>7.2 (17)</td>
</tr>
<tr>
<td><strong>MT</strong></td>
<td>19.6 (4)</td>
</tr>
<tr>
<td><strong>Mid Thinness</strong></td>
<td>40 (90)</td>
</tr>
<tr>
<td><strong>Wastethorntle</strong></td>
<td>7.1 (18)</td>
</tr>
<tr>
<td><strong>Wastethorntle</strong></td>
<td>4.0 (9)</td>
</tr>
<tr>
<td><strong>Primary school children</strong></td>
<td></td>
</tr>
<tr>
<td><strong>High Systolic</strong></td>
<td>2.7 (16)</td>
</tr>
<tr>
<td><strong>High Diastolic</strong></td>
<td>14.2 (27)</td>
</tr>
<tr>
<td><strong>Hypertension</strong></td>
<td>0.15 (2)</td>
</tr>
<tr>
<td><strong>Overweight</strong></td>
<td>2.0 (1)</td>
</tr>
<tr>
<td><strong>Sever Thinness</strong></td>
<td>0.8 (1)</td>
</tr>
<tr>
<td><strong>MT</strong></td>
<td>17.0 (2)</td>
</tr>
<tr>
<td><strong>Mid Thinness</strong></td>
<td>41.3 (90)</td>
</tr>
<tr>
<td><strong>Wastethorntle</strong></td>
<td>11.6 (24)</td>
</tr>
<tr>
<td><strong>Wastethorntle</strong></td>
<td>10.9 (24)</td>
</tr>
</tbody>
</table>

### Table 2

Number of subjects at risk at the initial measurements (mean age of 4.5 years for preschool and 8.1 years for primary school children) and tracking coefficient for over fatness calculated with generalized estimated equation over a period of 8 years from November 1996 to May 2003, Ellirias Longitudinal growth and health Study.

### Table 3

<table>
<thead>
<tr>
<th>Variables</th>
<th>Preschool children</th>
<th>Stability coefficienta</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Girls</td>
<td>Boys</td>
</tr>
<tr>
<td><strong>Systolic</strong></td>
<td>0.95 0.94</td>
<td>0.94 0.93</td>
</tr>
<tr>
<td><strong>Diastolic</strong></td>
<td>0.95 0.94</td>
<td>0.95 0.94</td>
</tr>
<tr>
<td><strong>BMI</strong></td>
<td>0.71 0.70</td>
<td>0.71 0.70</td>
</tr>
<tr>
<td><strong>Waist</strong></td>
<td>0.71 0.70</td>
<td>0.71 0.70</td>
</tr>
<tr>
<td><strong>Waist/gut</strong></td>
<td>0.71 0.70</td>
<td>0.71 0.70</td>
</tr>
<tr>
<td>**Hip/gut”</td>
<td>0.71 0.70</td>
<td>0.71 0.70</td>
</tr>
</tbody>
</table>

### Table 4

Regression coefficient and 95% confidence interval in the association of the initial cardiovascular risk factors for pre-school and primary school children measured from November 1999 to May 2003 (*= p<0.05).

### Table 5

Regression coefficient and 95% confidence interval in the association of the initial cardiovascular risk factors for pre-school and primary school children measured from November 1999 to May 2003 (*= p<0.05).
factor measurements and the subsequent measurements adjusted for age and maturation for preschool and primary school children. Both preschool and primary school children show a significant association between the first cardiovascular risk factor measurements and the subsequent measurement which ranged from $B = 0.14$ (95%CI 0.05 0.22) to $B = 0.99$ (95%CI 0.97-1.01) for preschool children $B= 0.27$ (95%CI 0.38 -0.41) to $B = 0.96$ (95%CI 0.94 0.97) for primary school children.

**DISCUSSION**

To assess the stability of certain variables in time or to assess the predictive value of variables which are measured in early life, the computation of tracking coefficients are considered to be critical in longitudinal epidemiological studies. Recommendations for interpreting tracking correlations are as follows: $< 0.3 =$ low, $0.3$ to $0.6$= moderate and $> 0.6 =$ high [Lurbe et al., 2005; Malina, 1996; Marshall et al., 1998]. Based on these recommendation, the results of this study indicate that BP, BMI, WHR and waist girth demonstrate high degree of tracking, while skin fold thickness demonstrate a moderate degree of tracking over a five year period in the Ellisras rural children.

Generally, the correlation coefficient vary considerably ($r=0.89-0.99$ for SBP and 0.81-0.98 for DBP) (Table3) and were higher when measurements were separated by shorter durations [Lauer and Clarke, 1984; Berenson et al., 1982]. As expected, in this study, adiposity BMI and BP had the highest degree of tracking which is similar to what was reported by Marshall et al. [1998]. However, Weder and Schork [1994] and Gerber and Stern [1995] suggested that because children who experience the earliest onset of the adolescent height spurt have the most vigorous linear growth rates and the shortest time to menarche, it is possible that acceleration of growth coupled with a shorter time frame of events, such as growth spurt and puberty, could aggravate asynchronies of
Among studies that examine BP tracking, some followed children for extended periods (more than 10 years) with measurements taken three or more years apart during the follow-up period. This study measured BP and anthropometric measurements of children every year over a 5 years period and therefore it was possible to show trends in cardiovascular risk factors over this period for every individual child. These measurements provide multiple cardiovascular risk factors measurements during childhood and help in predicting future hypertension and overweight in adulthood [Bao et al., 1986; Malina, 1996; Kemper et al., 2002]. Individuals classified as high in BP and BMI by multiple measurements were more likely to remain high after 5 years or more [Bao et al., 1986].

The fact that the prevalence of overweight increases (0 to 13.7%) over time among girls, and greater odds ratios found for overweight in primary school children raises a serious concern. There are no longitudinal studies conducted in the rural South African population to compare our results with. However, Reddy et al. [2003] and Department of Health [2004] reported similar results in a South African National Survey conducted in 2002 and 2003. According to these studies the prevalence of overweight increases up to 10% Nationally and up to 11.0% in the Limpopo Province of South Africa. Furthermore, the prevalence of thinness is rising in the present sample even during the adipose rebound (preschool children) (6.7 to 40.0%) and the adolescence stage (primary school children) (8.6 to 41.7%) which clearly shows lean mass than fat mass [Cole et al., 2007]. The increasing prevalence of thinness which is an indication of under nutrition supported by significant odds ratio (1.34 95%CI 1.26 1.43 to 1.9 95%CI 1.82 1.97) raises a serious concern as relative lean young black females appears to mature into relative obese black women later in life [Must et al., 1991].

Linear regression analysis confirms the tracking of BP, WHR and BMI during childhood and adolescent stages found in the correlation analysis. First, age and maturity were good predictor of BMI at an early age for both preschool and primary school children as reported earlier on in other studies [Dietz, 1994; 1997; Must et al., 1991; Ogden et al., 2002]. This may reflect the association between maturity, age and the adiposity during childhood and adiposity rebound during adolescence with girls having high BMI from 12.48 years (14.8kg/m2) for primary school children. Interestingly, girls continued high 14.34 years (18kg/m2). This is different from the study by Fuentes et al. [2003], Malina [1996] and Marshall et al. [1998] who showed girls having lower BMI during infancy and boys having a later adiposity rebound during childhood.

The magnitude of the stability coefficient does not give a direct answer to the question of whether or not subjects should be screened at an early age regarding cardiovascular risk factors. The second analysis was carried out in which ORs were calculated for subjects in the sex specific high risk quartiles in order to maintain their position after a longitudinal period of 5 years. Twisk et al. [1998] found almost similar odds ratios for SBP (OR=4.8) and DBP (OR=4.0) compared to those reported for the primary school children in the current study (OR =2.32 95%CI 1.26 2.41 for SBP and DBP (OR=2.59 95% CI 2.48 2.69). The advantage of calculating tracking for subjects “at risk” is that the magnitude of the odds ratio gives an indication of the preventative value of potential screening at an early age. However, the interpretation of the stability and tracking coefficient provide arguments in favor or against the screen ability of young subjects regarding hypertension and overweight. Before deciding on whether or not it is worthwhile to screen subjects at an early age, many other considerations should be taken into account. For example, firstly, the presented stability/tracking analysis focuses on the longitudinal development of hypertension and overweight and not the actual risk of developing hypertension and overweight. Lifestyle of individuals “at risk” is a risk factor for developing hypertension and overweight later in life. Secondly, there is no evidence, which suggest that screening and intervention in childhood and adolescence for hypertension, if accomplished, can prevent one from acquiring the risk factor later in life. Thirdly, screening procedure are costly and should not be ignored. However, the cost of screening can be greatly reduced if it is conducted as part of routine pediatric or diabetic care of a population. Finally, an important issue is the availability of preventative intervention methods. Changing lifestyle is the prime candidates for possible intervention for future studies.

Our study has some limitations. First, data in our study were not collected from a population based sample of obese black children of South Africa (who mostly attend the private schools), hence the information from such a small cohort of obese children in our sample could be attributed to chance. Secondly, we did not consider the socioeconomic status of the family of the participants.

We do have a powerful strength, however: as this was a prospective cohort study, the data are subject to less bias from recall, old measurements and may thus elucidate a true cause-and effect association. In addition, we measured BP and anthropometric measurements during early childhood, demonstrating that proper monitoring should be started from a child’s early days from a view point of screening for vulnerable individuals.

CONCLUSION

The prevalence of thinness in the Ellisras population increases with time. Though there is a slight increase in the prevalence of overweight for primary school girls over time, the prevalence of hypertension decreases with time for the same group of children. Cardiovascular risk factor tracking exist and permit early detection for future hypertension and does justify preventive measure on diet and way of life. Based on the present study and others, large scale screening of BP is not recommended, rather community based programs aimed at modifying health behavior in order to prevent development of cardiovascular risk factors and associated morbidity and mortality should be introduced.

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