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Physical Growth and Nutritional Status of a Cohort of Semi-Urban Nigerian Adolescents

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Abstract: The nutritional transition in developing countries may lead to imbalances in the growth and nutritional status of adolescents in such countries - events that could result in improper maturation and morbidity in adult life. This study seeks to determine the patterns of physical growth and nutritional status of adolescents living in a low income semi-urban town in Nigeria. Anthropometric data from six hundred and twenty five (625) secondary school students aged 10-19 years (adolescents) were collected and their Body Mass Index (BMI) calculated. Their heights and weights were compared to those of a reference population. Outcome measures for nutritional status were proportion of the population that is stunted (height-for-age < 3rd percentile of the reference data), thin and overweight/obese (BMI-for-age < 5th and > 85th percentiles of the reference data respectively). The girls matched the heights of half of the reference population at all ages, but the boys did not. From age fourteen years, the boys weighed less than half of the reference population while the girls matched or weighed more than the reference population. Under-nutrition was found to affect 19.36% of the population (with stunting accounting for 84.47% of this group), while 13.12% of the population were overweight/obese. The prevalence of thinness and stunting were higher in boys than in girls. Boys were also slightly more obese than the girls. Under- and over-nutrition co-exist in the population and affect more boys than girls. There is an urgent need to address these problems in preventive and curative health care programmes.

Key words: Adolescence, anthropometry, nutritional status, physical growth

INTRODUCTION

Adolescence is a period of rapid growth which begins with pubescence and continues until morphological and physiological changes approximate adult status. Adolescents are persons aged 10-19 years (WHO, 1986). They generally have a low prevalence of infectious diseases when compared to under-five children and chronic diseases when compared to ageing people. As a result of this, they have attracted little health and nutrition attention (Senderowitz, 1995; Wang *et al*., 1998). This is worrisome especially for developing countries where the proportion of adolescents in relation to other age groups is high and is expected to increase in the future (Blum, 1995).

Anthropometry is a useful non-invasive tool in the assessment of physical growth and nutritional status in adolescents (WHO, 1995). Growth may be responsive to nutritional surfeit or deficit. Therefore, anthropometry in adolescents can be used to evaluate nutritional abnormalities like stunting, thinness (under-nutrition) and obesity (over-nutrition). The US National Center for Health Statistics (NCHS) and the first US National Health and Nutrition Examination Survey (NHANES 1) reference data provide veritable tools for comparing anthropometric indices and nutritional status from different populations (Hamill *et al*., 1979; Must *et al*., 1991a and b).

Nigeria, a developing country, like the other countries in that category, is experiencing changes in the dietary patterns of her people, as a result of the prevailing nutritional transition. This transition often comes with changes in habits that predispose to overweight and obesity at adolescence, which tends to persist into adulthood with its sequelae (Serdula *et al*., 1993; Popkin, 1994), while the reverse (under-nutrition), could result in improper maturation (Agarwal *et al*., 1995). In view of these problems and the high poverty level in Nigeria, assessing the physical growth and nutritional status of Nigerian adolescents, dwelling in a low income semi-urban town (where majority of Nigerians live) is important as it would provide data that may help in prevention, intervention and rehabilitation programmes. This study attempts to fill that gap.

MATERIALS AND METHODS

Setting: Nigeria's population (estimated in the year 2000) is distributed as follows: 0-14 years - 44% (male 27,181,020; female 26,872,317); 15-64 years - 53%

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(male 33,495,794; female 32,337,193); 65 years and over - 3% (male 1,729,149; female 1,722,349). The census 2006 preliminary results however put the total population of Nigeria at 140,003,542 (Wikipedia, 2007). A 1999 estimate by the World Health Organization puts life expectancy at birth for males and females at 46.8 and 48.2 years respectively. In the developed world, the figures are much higher (74.7 years and 79.7 years for American males and females respectively) (WHO, 2000). On the other hand, total fertility rate in Nigeria is at 5.66 children per woman while mortality rate is at 74.18 deaths per 1000 live births (Wikipedia, 2007). In Western Europe, the figures contrastingly stand at 1.5 children per woman and 10 deaths per 1000 live births. Nigeria's Gross Domestic Product (GDP) per capita (2004 estimate) stood at $560 (USD) as against $44,670 (USD) in Denmark and $30,941(USD) in the United States of America (USA) (Microsoft, 2007). The 1997 WHO per capita health expenditure estimate for Nigeria was $30 (USD) while Denmark had $1940 (USD) and the USA had $ 3724 (USD) (WHO, 2000). Nigeria, clearly, has the markers of a low income country.

Ajaokuta is a small semi-urban town in Kogi state, North-Central Nigeria. Virtually all the people dwelling in the town are either subsistence farmers or unskilled artisans (only a negligible proportion work in the almost moribund Iron and Steel Complex located there) and therefore belong to the low income socio-economic status group. Tropical tubers like cassava (*Manihot esculenta*) and yam (*Diascoria spp)* and maize (*Zea* mays) are the major agricultural products of these farmers and therefore provide their staple food. Legumes and meat are protein sources for the population. But legumes are seasonal in availability (due to an absence of storage facilities), while meat is expensive and often out of reach of low income people. Ajaokuta typifies the average Nigerian experience and hence its choice as a setting for this study.

Subjects: Students from two public secondary schools in Ajaokuta (with no signs of overt ill-health) whose parents or legal guardians gave informed consent were allowed to participate in the study.

The study was conducted from October to December (the harvest period in Nigeria) of 2007. A total of six hundred and twenty five (625) adolescents (374 males of mean age 14.27±2.15 and 251 females of mean age 14.32±2.27 years) participated in the study. Data on students' ages were obtained from their school records. Age at last birthday was recorded for each student. Height was measured (with the student standing on bare feet) using a non-elastic measuring tape fastened to a vertical rod, to the nearest 0.5 cm. Weight was measured (with the student on bare feet and with light clothing) using an electronic weighing balance, to the nearest 0.1 kg. From the heights and weights got, Body Mass Index (BMI) was calculated using the formula BMI = Weight (kg)/[Height (m)]^2. To assess the growth and nutritional status of the participants, their heights, weights and BMI were compared to those of an age-matched reference population (Hamill *et al*., 1979; Must *et al*., 1991a; Must *et al*., 1991b). Stunting (a measure of chronic under-nutrition) is defined as height-for-age < 3rd percentile of the NCHS percentiles (Hamill *et al*., 1979), while obesity (a measure of over-nutrition) and thinness (a measure of present under-nutrition) are defined as BMI-for-age > 85th percentile and BMI-for-age < 5th percentile of the NHANES 1 reference data (Must *et al*., 1991a; Must *et al*., 1991b) respectively. Stunted and thin adolescents were taken to be undernourished.

The same trained personnel took all measurements in both locations. The weighing balance was appropriately calibrated before use each morning. Measurements were taken between 8 am and 10 am each day throughout the duration of the study. The study protocol was prepared in accordance with the Helsinki Declaration and was approved by the Human Experiments Review Board of the Department of Biochemistry, Kogi State University, Anyigba. Additional approvals were sought and obtained from the principals of participating schools.

Data analysis: Mean values for the different data collected in the appropriate groups were calculated and differences between means separated by one way ANOVA. The Least Significant Difference (LSD) was fixed at 0.05. All data analysis was done using SPSS for windows version 11.0 (SPSS Inc. Chicago, IL). Results are presented as percentages and means with standard deviations from means in table and line graphs respectively.

RESULTS

The means of the anthropometric parameters studied and those of the reference population are given in Fig. 1-3. At ten years, the boys were significantly ($p<0.05$) taller than the girls. By twelve years, the girls had caught up with the boys. Both boys and girls aged 10 and 11 years were taller than 50% (height-for-age >50th percentile) of the reference population. From 12 years onwards, the females were about the same height as 50% of their age-matched counterparts. The boys matched the heights of 50% of the reference data only at ages 12 and 13 years. From age 14 years onwards, the boys were shorter than 50% of the reference population. In fact from age 16-19 years, the boys were shorter than 95% (height-for-age < 5th percentile) of the reference population. The increases in height with age for both sexes were significant ($p<0.05$), except between the ages of 10 and 11 years and 16-19 years.

The males weighed more than 50% of the reference population from 10-13 years. Thereafter, they weighed less than 50% of the reference group, but more than

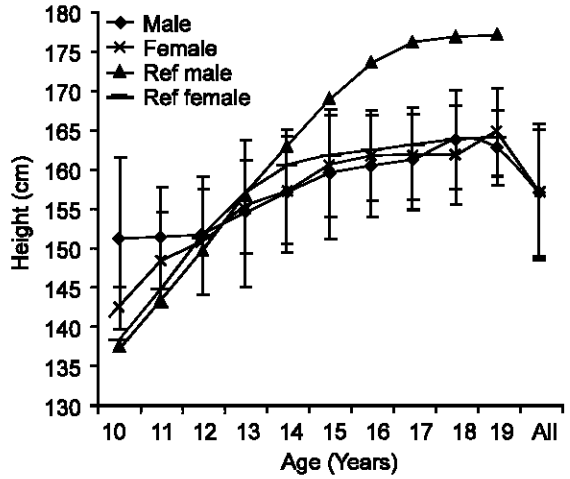

Fig. 1: Comparison of the heights of the participants to the median (50th percentile) heights of an age-matched reference population

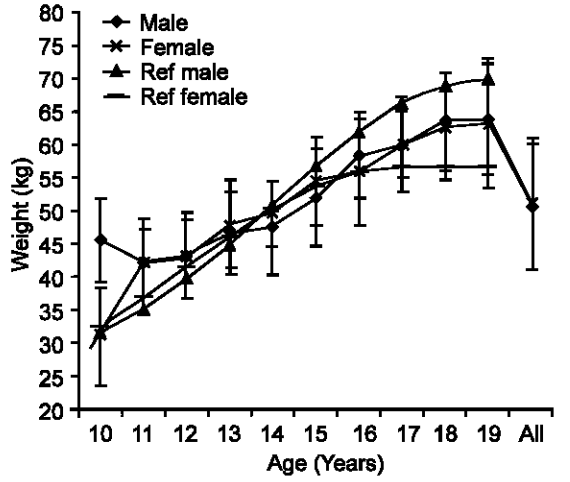

Fig. 2: Comparison of the weights of the participants to the median (50th percentile) weights of an age-matched reference population

25% (weight-for-age >25th percentile) of the same group. The females, at 10 years had a smaller mean weight than that of 50% of their age-matched counterparts. However, at ages 11 and 12 years, the females weighed heavier than 50% of the reference population. Between the ages of 13 and 16 years, the weights of the females matched that of 50% of the reference group. From age 17 years onwards, the females became markedly heavier than 50% of the reference population, but still lighter than 10 % (weight-for-age < 90th percentile) of the same population. In the sampled population, the boys were significantly ($p<0.05$) heavier than the girls (at 10 years), the difference being as much as 14 kg. The girls however equilibrated with the boys at age 11 years and both increased with age while the difference between

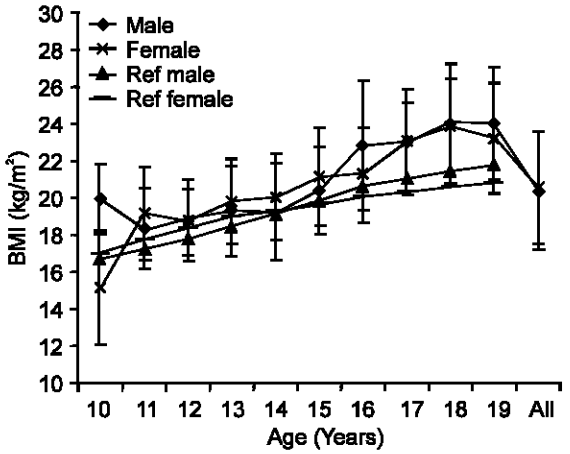

Fig. 3: Comparison of the weight-to-height ratio (BMI) of the participants to the median (50th percentile) BMI of an age-matched reference population

their means was insignificant ($p>0.05$). For both sexes, the differences in the weights of the different ages were significant ($p<0.05$) except between those aged 10 and 11years and those aged 18 and 19 years.

For BMI, the same trend for height and weight was noticed for the boys and the girls. Except at age 14 years, the boys had clearly more BMI than 50% of the reference population, but their BMI was still less than that of the top 15% (BMI-for-age < 85th percentile) of the same population. The females at all ages had higher BMI than 50% of the reference group (except at 10 years). Their BMI were however less than the top 15% of the reference group.

More boys were thin (4.81% compared to 2.39% of the girls), stunted (23.80% compared to 4.78% of the girls) and obese (24.60% for boys and 4.78% for girls) (Table 1). The thin boys were between the ages of 11 and 16 years. Obesity was found in all ages for the boys. Girls aged 10, 12, 18 and 19 years had no case of obesity. Stunting was found in boys from age 12-19 years and in girls from age 13-19 years (though none was found to be stunted at age 17 years). A total of 46.79% of the boys and 86.79% of the girls studied had no detectable nutritional impairment, while 37.28% of the studied population (irrespective of sex) suffer from under- (20.00%) or over- (17.28%) nutrition. Stunting accounted for 80.80% of the undernourished group.

DISCUSSION

Mean BMI for boys and girls of all ages were within the normal ranges of the reference data. Only the heights of the boys aged 14 years and above fell below acceptable ranges. However, as much as 23.80% of the boys and only 4.78% of the girls had height-for-age values lower than the 3rd percentile of the reference data. This

Table 1: Prevalence of thinness, obesity and stunting in the population

Age (Years)	Thinness (%)			Obesity (%)			Stunting (%)		
	Boys (N)	Girls (N)	All (N)	Boys	Girls	All	Boys	Girls	All
10	0.00 (12)	10 (10)	4.55 (22)	50.00	0.00	27.27	0.00	0.00	0.00
11	11.11 (27)	4.55 (22)	8.16 (49)	29.63	18.18	24.49	0.00	0.00	0.00
12	6.25 (32)	0.0 (20)	3.85 (52)	34.38	0.00	21.15	3.13	0.00	1.92
13	3.08 (65)	0.00 (41)	1.89 (106)	18.46	2.44	12.26	6.15	4.88	5.66
14	6.98 (86)	8.70 (46)	7.58 (132)	17.44	2.74	12.12	11.63	10.87	11.36
15	6.90 (58)	0.00 (36)	4.26 (94)	13.79	22.22	17.02	25.86	2.78	17.02
16	3.33 (30)	0.00 (28)	1.72 (58)	43.33	3.57	24.14	46.67	3.57	25.86
17	0.00 (27)	0.00 (23)	0.00 (50)	25.93	4.35	16.00	74.07	0.00	40.00
18	0.00 (24)	0.00 (19)	0.00 (43)	29.67	0.00	16.28	66.67	10.53	41.86
19	0.00 (13)	0.00 (6)	0.00 (19)	38.46	0.00	26.32	69.23	16.67	52.63
Total	4.81 (374)	2.39 (251)	3.84 (625)	24.60	6.37	17.28	23.80	4.78	16.16

disparity in the prevalence of stunting between the sexes agrees with the reports of Jackson *et al.* (2002), Venkaiah *et al.* (2002), Ukegbu *et al.* (2007) and Wamani *et al.* (2007). The same trend was noticed for thinness as more boys than girls had BMI-for-age values below the 5th percentile of the reference data.

The 20.00% prevalence rate for adolescent under-nutrition reported in this study is higher than the 8.7% reported for Jamaica (Jackson *et al.*, 2002), 18% reported for China (Wang *et al.*, 1998) and 18.9% reported (for adolescents enrolled in private school) in Pakistan (Din and Paracha, 2003), but lower than the 23.00%, 36.00% and 53.00% reported for Benin, Nepal and India respectively (Kurtz, 1996) and 42.2% reported for adolescents in a Pakistani public school (Din and Paracha, 2003). The high prevalence of stunting among boys aged 15 years and above agrees with a report from another part of Nigeria (Ukegbu *et al.*, 2007) but is terribly high when compared to the 3% reported in Jamaica (Jackson *et al.*, 2002). This prevalence of under-nutrition in adolescents is high as it suggests that one in five adolescents in the study area is undernourished. It is also of great concern since under-nutrition may affect the maturation (Agarwal *et al.*, 1995; Grantham-McGregor, 1995) and later physical work capacity (Haas *et al.*, 1996) of the individual. Stunting is attributable to low birth weight (Espo *et al.*, 2002), inadequate care and stimulation (Begin *et al.*, 1999), insufficient nutrition and recurrent infections (Cole and Parkin, 1997) and other environmental determinants. For this reason, stunting is said to capture the multiple dimensions of children's health, development and the environment where they live (Wamani *et al.*, 2007).

The prevalence of obese adolescents in the study is 17.28% (24.60% for boys and 6.37% for girls). The figure is a lot higher than the 4% reported for China (Wang *et al.*, 1998) but lower than 19.3% and over 20% found in Jamaica and the United States of America respectively (Jackson *et al.*, 2002; Troina *et al.*, 1995). The current report however shows that obesity was as high in boys as in the USA, but apparently still low in the girls. This clearly disagrees with the reports of Gam *et al.* (1986), Dietz (1994), Jackson *et al.* (2002) and Monyeki *et al.* (2008) that report a higher prevalence of overweight and obesity in girls, but agrees with Ukegbu *et al.* (2007). This prevalence of adolescent obesity is relatively high and is worrisome since obesity in adolescence often persists to adulthood (Popkin, 1994), especially for females (Dietz, 1994).

The fact that a considerably high percentage of the population was stunted and only a very small proportion was thin, suggests that the cause of the noticed under-nutrition in the population is chronic. Thinness disappeared at 15 years in the girls and at 17 years in the boys, yet the percentage of the population that was stunted kept increasing. This suggests an imbalance in the food intake of the population in favour of high energy yielding foods. This is not entirely surprising as the population subsists largely on starchy carbohydrates. Though there was an apparent attempt at catch-up growth in the population, it resulted in increase in weight without a collateral increase in height. The acute consumption of these high energy foods may be responsible for the noticed obesity in the population. Catch-up growth has also been shown to increase the chances of becoming obese (Espo *et al.*, 2002). Martotell *et al.* (1994) however, report that catch-up is incomplete, particularly for those remaining within the same adverse environment. How these affect boys and girls disproportionately is still unclear. The high BMI in some of the boys may be due to a relatively high muscle mass as a result of cultural practices that require males to do the heavy (probably muscle building) tasks.

Conclusion: In conclusion, both under- and over-nutrition co-exist at different prevalence levels in the studied adolescent population. The observed under-nutrition is due largely to chronic deprivation. These findings show the effects of the nutrition crisis in low income areas like Ajaokuta, Nigeria and highlight the dilemma it presents to such societies who still have infectious/ communicable diseases to tackle. Most semi-urban and rural girls marry and conceive as adolescents.

Adolescents also provide a good proportion of the productive work force in such environments. There is, therefore, an urgent need to develop strategies to improve the growth and nutritional status of adolescents. Our study is representative of school-going adolescents in Ajaokuta and may not represent the others. We had few people at the ages of 10 and 19 years, because most people enroll into secondary school at age 11-12 years and graduate at 17-18 years. This therefore calls for a cautious interpretation of the data, especially at those two ages.

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REFERENCES

Agarwal, K.N., D.K. Agarwal and S.K. Upadhydal, 1995. Impact of chronic undernutrition on higher mental function in boys aged 1-12 years. Acta Peadiatr, 84: 1357-61.

Begin, F., E.A. Frongillo Jr. and H. Delisle, 1999. Caregiver behaviours and resources influence child height-for-age in rural Chad. J. Nutr., 129: 680-6.

Blum, R.W., 1995. Global trends in adolescent health. J. Am. Med. Assoc., 265: 2711-9.

Cole, T.J. and J.M. Parkin, 1997. Infection and its effect on growth of young children: a comparison of the Gambia and Uganda. Trans. R Soc. Trop. Med. Hyg., 71: 196-8.

Dietz, W.H., 1994. Critical periods in childhood for the development of obesity. Am. J. Clin. Nutr., 59: 955-9.

Din, Z.U. and P.I. Paracha, 2003. Assessment of nutritional status of adolescent boys from public and private schools of Peshawar. Pak. J. Med. Res., 42: 129-33.

Espo, M., T. Kulmala, K. Maleta, T. Cullinan, M.L. Salin and P. Ashon, 2002. Determinants of linear growth and predictors of severe stunting during infancy in rural Malawi. Acta Paediatric, 91: 1364-70.

Gam, S.M., M. La Velle, K.R. Rosenberg and V.M. Hawthorn, 1986. Maturational timing as a factor in female fatness and obesity. Am. J. Clin. Nutr., 43: 879-83.

Grantham-McGregor, S., 1995. A review of the studies of the effects of severe malnutrition on mental development. J. Nutr., 125: S2233-8.

Haas, J.D., S. Murdoch, J. Rivera and R. Martorell, 1996. Early nutrition and later physical work capacity. Nutr. Rev., 54: S41-8.

Hamill, P.V.V., T.A. Drizd, C.L. Johnson, R.B. Reed, A.F. Roche and W.M. Moore, 1979. Physical growth: National Centre for Health Statistics percentiles. Am. J. Clin. Nutr., 32: 607-629.

Jackson, M., M. Samms-Vaughan and D. Ashley, 2002. Nutritional status of 11-12 years-old Jamaican children: coexistence of under- and over-nutrition in early adolescence. Public Health Nutr., 5: 281-288.

Kurtz, K.M., 1996. Adolescent nutritional status in developing countries. Proc. Nutr. Soc., 55: 321-331.

Martotell, R., L. Kettel-Khan and D.C. Schweder, 1994. Reversibility of stunting: Epidemiological findings in children from developing countries. Eur. J. Clin. Nutr., 4: S45-57.

Microsoft, 2007. Microsoft Encarta encyclopeadia premium suite. (DVD). Microsoft corporation USA .

Monyeki, K.D., M.A. Monyeki, S.J. Brits, H.C.G. Kemper and P.J. Makgae, 2008. Development and tracking of body mass index from preschool age into adolescence in rural South African children: Ellisras Longitudinal Growth and Health Study. J. Health Popul. Nutr., 26: 405-17.

Must, A., G.E. Dallal and W.H. Dietz, 1991a. Reference data for obesity: 85th and 95th percentiles of body mass index (wt/ht^2) and triceps skinfold thickness. Am. J. Clin. Nutr., 53: 839-46.

Must, A., G.E. Dallal and W.H. Dietz, 1991b. Reference data for obesity: 85th and 95th percentiles of body mass index (wt/ht^2) -a correction. Am. J. Clin. Nutr., 1991 54: 773.

Popkin, B.M., 1994. The nutrition transition in low-income countries: an emerging crisis. Nutr. Rev., 52: 285-98.

Senderowitz, J., 1995. Adolescent health: reassessing the passage to adulthood. World Bank Discussion Paper No 272. World Bank, Washington DC.

Serdula, M.K., D. Ivery, R.J. Coates, D.S. Freeman, D.F. Williamson and T. Byers, 1993. Do obese children become obese adults? A review of the literature. Prev. Med., 22: 167-77.

Troina, R.P., K.M. Flegal, R.J. Kuczmarski, S.M. Campbell and C.L. Johnson, 1995. Overweight prevalence and trends for children and adolescents. Arch Ped. Adolesc Med., 149: 1085-91.

Ukegbu, P.O., I.A. Onimawo and A.U. Ukegbu, 2007. Nutritional status and energy intake of adolescents in Umuahia urban, Nigeria. Pak. J. Nutr., 6: 641-6.

Venkaiah, K., K. Damayanti, M.U. Nayak and D. Vijayaraghavan, 2002. Diet and nutritional status of rural adolescents in India. Eur. J. Clin. Nutr., 56: 1119-25.

Wamani, H., A.N. Åstrøm, S. Peterson, J.K. Tumwine, and T. Tylleskär, 2007. Boys are more stunted than girls in Sub-Saharan Africa: a meta-analysis of 16 demographic and health surveys. BMC Pediatr, 7: 17.

Wang, Y., B. Popkin and F. Zhai, 1998. The nutritional status and dietary patterns of Chinese adolescents 1991 and 1993. Eur. J. Clin. Nutr., 52: 908-16.

Wikipedia, 2007. Demography of Nigeria. Retrieved from http://en.wikipedia.org/wiki/demography_of_Nigeria, on Monday 31st December 2007.

World Health Organization, 1986. Young Peoples Health: A challenge for society. Technical report series No 731, WHO Geneva.

World Health Organization, 1995. Physical status: The use and interpretation of anthropometry. Technical report series No 854, WHO Geneva.

World Health Organization, 2000. Health systems: Improving performance. The world health report. WHO Geneva.