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Assessment of the Growth of Children and Physical Status of Adults in Two Aboriginal Communities in South Australia

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ABSTRACT Growth of children and physical status of adults in two Aboriginal communities, Gerard and Raukkan, South Australia, were assessed. Height, weight, biepicondylar breadth of humerus, the triceps and subscapular skinfolds, and arm circumferences were measured on 110 children and 77 adults annually between 1996 and 2000. Data were transformed to *z* scores, using American reference data. In all groups height *z* scores are negative. In all but Raukkan boys, the *z* scores are significantly smaller than the reference. Body weight *z* scores lie above the reference, with the only exceptions being Gerard children. Still, in all cases BMI lies above the reference, being significantly greater than the reference, except in Gerard girls. *z* scores for the triceps skinfold are not consistently positive, but those for the subscapular skinfold are positive in all groups, indicating centralized fat accumulation. In both boys and girls, Raukkan men and Gerard women, biepicondylar breadth of the humerus is below the reference. Increased BMI and trunk fatness suggest that members of these communities are not only receiving adequate nutrition, but that in many cases there is also a caloric surplus, sometimes leading to obesity. Inadequate skeletal growth indicated by short stature and small biepicondylar breadths, on the other hand, suggests that the environment is less than optimal for growth. Factors such as disease load, psychosocial pressures, or specific nutrient shortages may be involved. Am. J. Hum. Biol. 13:603–611, 2001. © 2001 Wiley-Liss, Inc.

Body size, body composition, and elements of motor performance are influenced by living conditions. They are often used as indicators factors of socio-economic conditions that are biologically relevant. A number of anthropometric studies have been carried out at various times on Aboriginal Australians (Taplin, 1879; Wood Jones and Campbell, 1924; Kettle, 1966; Abbie, 1975; Barrett and Brown, 1971; Brown and Townsend, 1982). These, however, were mainly concerned with recording biological characteristics of a group of people who remained for millennia in relative isolation from the rest of humanity, while living in rather extreme geographical conditions. Thus members of Aboriginal communities did not consider anthropometric studies to be of any benefit to their communities. Consequently in recent times it has been difficult to obtain permission for anthropometric studies in Aboriginal communities.

Since the European settlement of Australia, Aboriginal communities have undergone significant changes. Their gene pools were mixed due to extensive population movements following vagaries of policies towards indigenous people, competition for land with settlers, government-organized food distribution, availability of jobs, creation of "reserves" and, since the granting of citizenship in 1967, provision of welfare and migration to major towns and cities. There was also a reverse migration, that of non-Aborigines into Aboriginal communities. Living conditions in the Aboriginal communities are still not on a par with those in mainstream Australian cities and towns. Aboriginal communities in general have poorer access to food supplies, educational opportunities, and health services than the majority of Australians who live in highly urbanized, first-world communities. Because Aboriginal communities have a degree of self-government, there are also differences between particular communities in general living conditions. These depend on numerous factors, including the individual initiative of community leaders, health workers, and access to neighboring mainstream services. This situation may impact the health of children and thus affect physical growth and development. While various

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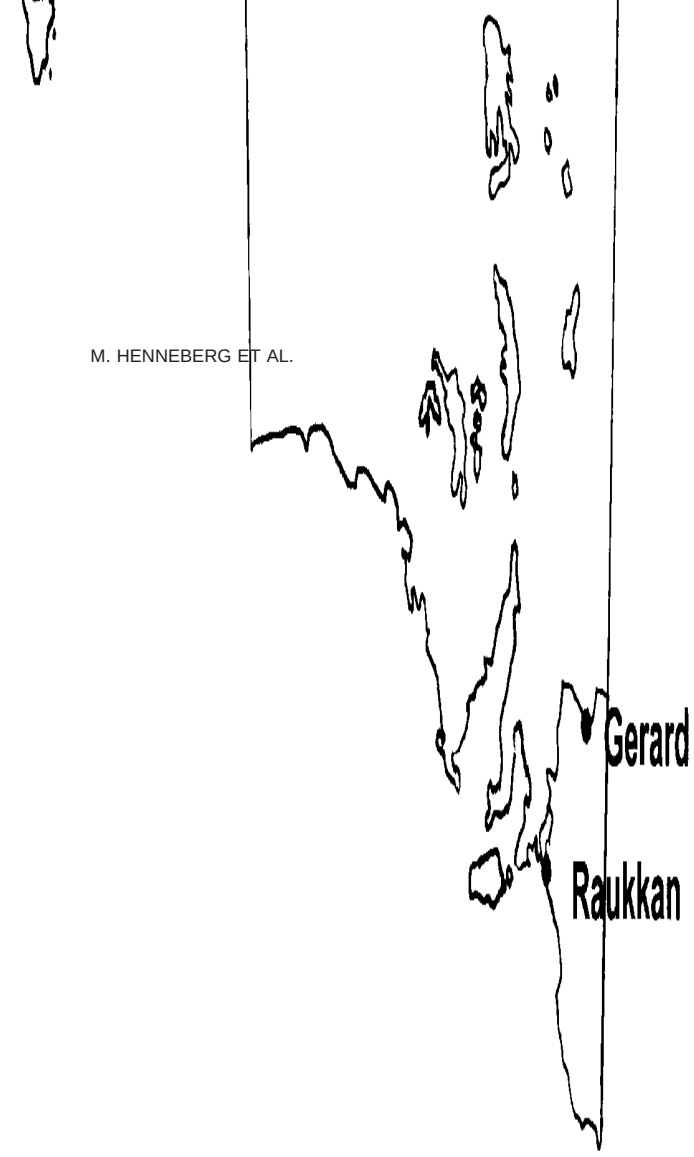


Fig. 1. Location of the communities studied. The borders are those of the State of South Australia. Note that both communities are located on the Murray River.

econometric statistics describing the well-being of Aboriginal communities may be subject to reporting errors and biases, the growing bodies of children in Aboriginal communities provide a measurable, physical testimony to the conditions in which they live.

The authors were invited by the governing Councils of two South Australian Aboriginal Communities, Gerard and Raukkan, to conduct surveys of their members' physical status. The communities each consist of approximately 120 individuals. There is considerable movement into and out of each community, as their members often leave to search for employment. Small population size coupled with varying levels of individual informed consent necessarily limited the number of individuals that could be measured. This study aims to assess the physical status of children and adults in these two Aboriginal communities irrespective of their biological origin, which in many cases reflects the history of over 150 years of mixing between members of various Aboriginal groups and immigrants. It should not, therefore, be regarded as a study of Aboriginal people as members of a separate population with a specific gene pool.

MATERIALS AND METHODS

The data were collected from the Aboriginal communities of Gerard and Raukkan in the Lower River Murray region in South Australia (Fig. 1). The two communities differ significantly in their history and current status. Raukkan, located at Point McLeay, near the mouth of the River Murray, was established as a mission station by Reverend George Taplin in 1859. Since then it has been a center of Aboriginal life in its region, producing, among other well-known personalities, an inventor, lecturer, and writer David Unaipon, the only Aboriginal Australian whose face currently adorns banknotes of Australian currency ($50). Today the self-

governing community of about 120 people is housed in modern well-maintained suburban-style houses, owns a large and productive farm, has a separate well-equipped primary school, and is governed by an energetic and well-organized Council. The Council has prohibited the public consumption of alcoholic beverages.

Gerard is located in the upper Murraylands, near Berri in the vicinity of the border between South Australia, Victoria, and New South Wales. It is nesting in a loop of the Murray River in isolation from the farming communities of the Riverland. Gerard was established in 1945 to receive Aborigines being moved out from other reserves scattered along the Murray. Over the years the housing conditions have been improved, but even today accommodation presents a mixture of small poorly built cottages and solid but less well maintained suburban-style houses. A new building for the Community Centre and Health Centre was only constructed in 1997. The community owns a large almond orchard and a yabbie (freshwater crayfish) farm, but these ventures are only partially successful despite the efforts of some energetic individuals. The governing Council has been less successful than in Raukkan at promoting the health and welfare of the community. The poor state of repair of some buildings and the lack of a local school are the external manifestations of this situation. School age children have to commute to a general school at the 10-km distant town of Winkie.

Data were collected in July 1996, January 1997 (Pretty et al., 1998), March 1998, February 1999, and February/March 2000 in a cross-sectional study which provides a basis for a mixed longitudinal study currently under way. Over the five years of the study 110 children aged between <1 year and 18 years (28 girls each from Gerard and Raukkan, 21 boys from Gerard, and 33 boys from Raukkan), together with 77 adults (23 women and 23 men from Gerard, and 16 women and 15 men from Raukkan) were measured at least once. Data collected on one occassion only for each individual are used here, so that this report is cross-sectional.

The study was conducted at the written request of both communities and was approved by the University of Adelaide Human Ethics Committee. Written consent of each participant or of parents of children below legal adult age was obtained. All participants were examined without their shoes and wearing only light clothing. A standard GPM anthropometer was used to measure the distances from the floor to the following points defined in Martin and Saller (1957): vertex (v), tragion (t), acromion (a), suprasternale (sst), symphysion (sy), and dactylion (da). A spreading caliper was used to measure shoulder width (a–a) and hip width (ic–ic). Biepicondylar widths of the humerus and femur were taken with a sliding caliper. Chest and arm circumferences were measured with a measuring tape. In the measurement of chest circumference, the tape was passed over the inferior angles of the scapulae and over the sternomanubrial joint. The triceps and subscapular skinfolds were measured with a Holtain caliper. All measurements were taken to the nearest millimeter and recorded and processed in accordance with the requirements of the SI system of measures (International Bureau of Weights and Measures, 1970). The exceptions were the circumferences, which were recorded to the nearest 5 mm. Weight was measured with a portable electronic scale (Salter), which was regularly calibrated.

All examinations were carried out by a team trained and supervised by M. Henneberg who was present throughout the time of all examinations. United States reference data (Frisancho, 1990) were used as the standard to derive z scores for height, weight, the Body Mass Index (BMI), biepicondylar breadth of humerus, arm circumference, and triceps and subscapular skinfolds. F-tests and t-tests were used for statistical analysis. Results for those anthropometric variables that were compared against the American reference are reported.

RESULTS

Average z scores and standard deviations are shown in Table 1. Graphs of body height, body weight, the BMI, and the subscapular skinfold of all measured members of the Aboriginal communities in comparison to the United States reference are presented in Figures 2–5.

For both males and females of Gerard and Raukkan, averages of body weight are either insignificantly different from zero or significantly above the American reference, while average z scores of body height are mostly significantly negative. Height of

TABLE 1. Average z-scores for boys, girls, men and women from Gerard and Raukkan. Data compared to the United States reference (Frisancho 1990)

	Gerard			Raukkan		
	N	*z*	*s*	*N*	*z*	*s*
		Boys			Boys	
Weight	21	–0.119	0.905	33	0.309	1.172
Height	21	–0.561*	0.921	33	–0.123	1.123
Biepi. humerus	21	–0.718*	1.227	32	–0.122	1.193
Arm circumference	21	–0.239	0.734	33	0.141	1.053
Skinfolds: triceps	21	0.216	0.560	33	0.293*	0.682
Subscapular	21	0.457*	0.515	32	0.727*	0.929
BMI	20	0.404*	0.753	33	0.514*	1.258
		Girls			Girls	
Weight	28	–0.015	1.075	27	0.408	1.132
Height	28	–0.509*	0.980	28	–0.455*	1.107
Biepi. humerus	27	–0.996*	1.140	26	–0.125	1.103
Arm circumference	28	–0.311	0.726	28	0.068	0.733
Skinfolds: triceps	27	–0.140	0.882	28	0.136	0.868
Subscapular	27	0.752*	1.118	25	1.052*	0.963
BMI	28	0.368	1.005	27	0.815*	0.845
		Men			Men	
Weight	23	0.389	1.198	15	0.404	0.974
Height	23	–0.561*	0.915	15	–0.676*	0.573
Biepi. humerus	23	0.020	0.948	15	–0.28	1.220
Arm circumference	23	–0.475	1.267	15	–0.100	1.037
Skinfolds: triceps	23	–0.504*	0.517	15	0.177	0.815
Subscapular	23	0.520*	1.120	14	0.931*	0.629
BMI	23	0.706*	1.173	15	0.813*	1.089
		Women			Women	
Weight	23	0.653*	1.166	16	1.155*	1.267
Height	25	–1.109*	0.715	16	–0.850*	0.642
Biepi. humerus	25	–0.536	1.410	16	0.373	1.268
Arm circumference	25	–0.161	1.768	16	0.354	1.402
Skinfolds: triceps	25	–0.382	0.914	15	0.234	1.007
Subscapular	24	1.185*	1.012	14	1.196*	0.890
BMI	23	1.121*	1.307	16	1.587*	1.320

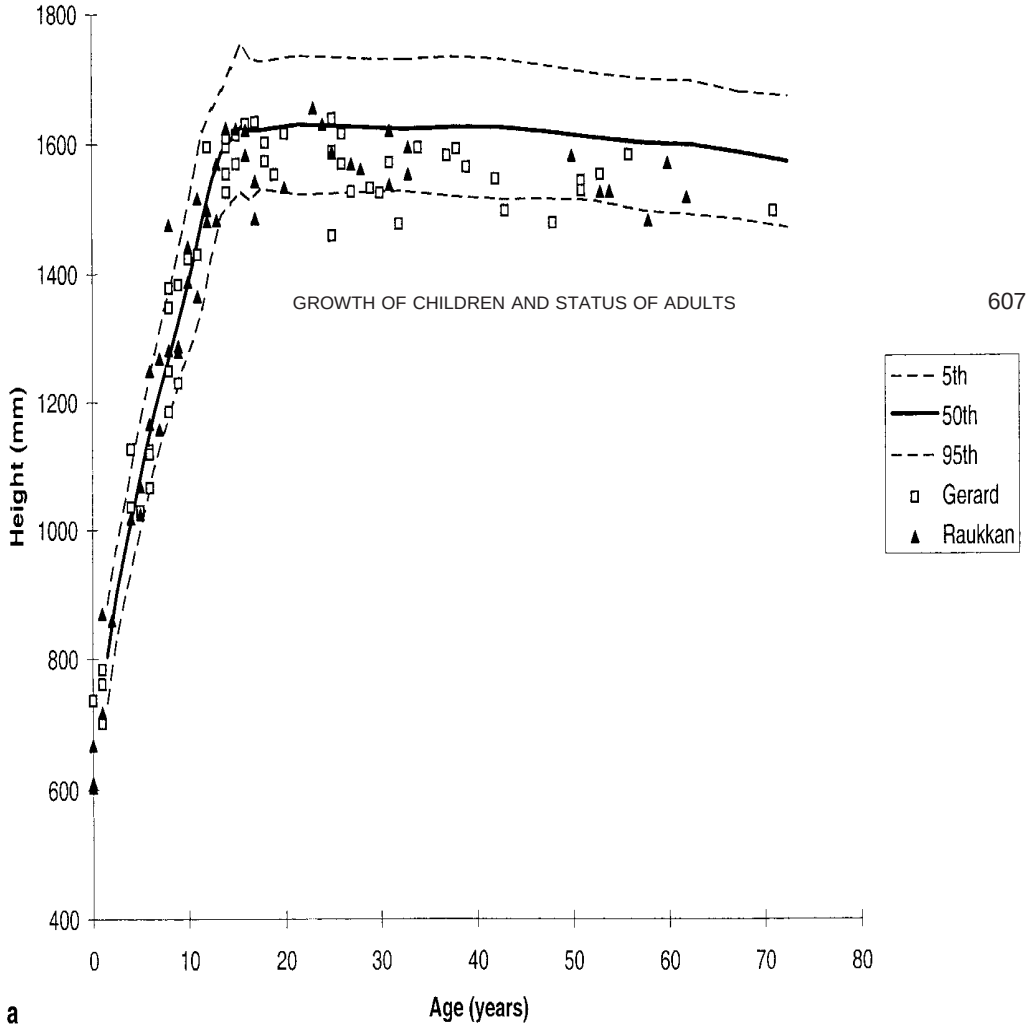
*Significantly different from zero ($P < 0.05$).

Gerard boys and girls is significantly smaller than that of the reference, while in Raukkan boys the *z* score of height, although negative, is not significant, while that for girls is significantly negative.

In both communities *z* scores for the BMI are, on the average, greater than the reference and in most cases significantly so (boys in Gerard and Raukkan, girls in Raukkan, and all adults). The significantly increased BMI is not reflected in average *z* scores of the triceps skinfold, but *z* scores of the subscapular skinfold are significantly increased in all groups, indicating centralized accumulation of subcutaneous fat.

Biepicondylar width of the humerus is significantly below the reference in Gerard girls and boys. The *z* score is somewhat less negative and insignificantly different from zero in Raukkan. It should be noted that, although the difference is insignificant, biepicondylar width of humerus is also smaller than the reference in Gerard women and in Raukkan men.

There are some differences between the two communities that indicate the physical status of inhabitants of Raukkan is less different from the reference than those from Gerard. Average body height *z* scores of boys, girls, and women from Raukkan, though still below the reference, are less negative than those of people from Gerard. Average biepicondylar breadth *z* scores are lower amongst boys, girls, and women in Gerard than in Raukkan, and these differences are significant. Average arm circumference *z* scores for all groups in Gerard are lower than those for inhabitants of Raukkan, but the differences are not significant. Inhabitants of Gerard have consistently lower average triceps skinfold thicknesses than inhabitants of Raukkan, but the differences are significant only among adults. Average subscapular skinfold thicknesses are



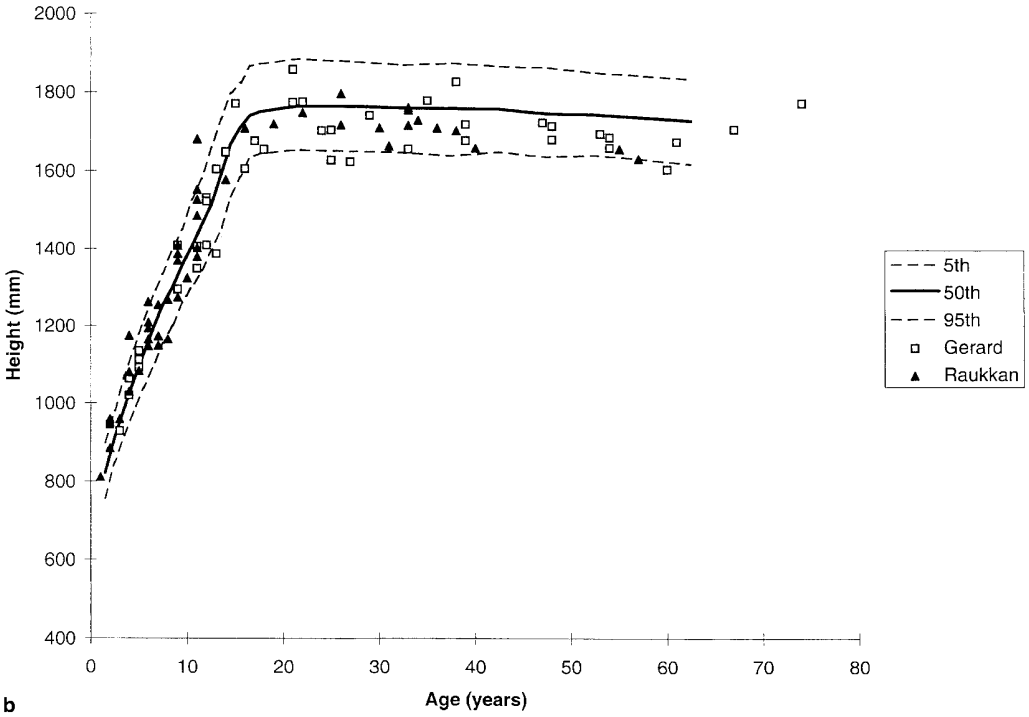


Fig. 2. Plot of height (mm) by age for **(a)** females and **(b)** males from Gerard and Raukkan. Data are plotted against American reference (Frisancho, 1990).

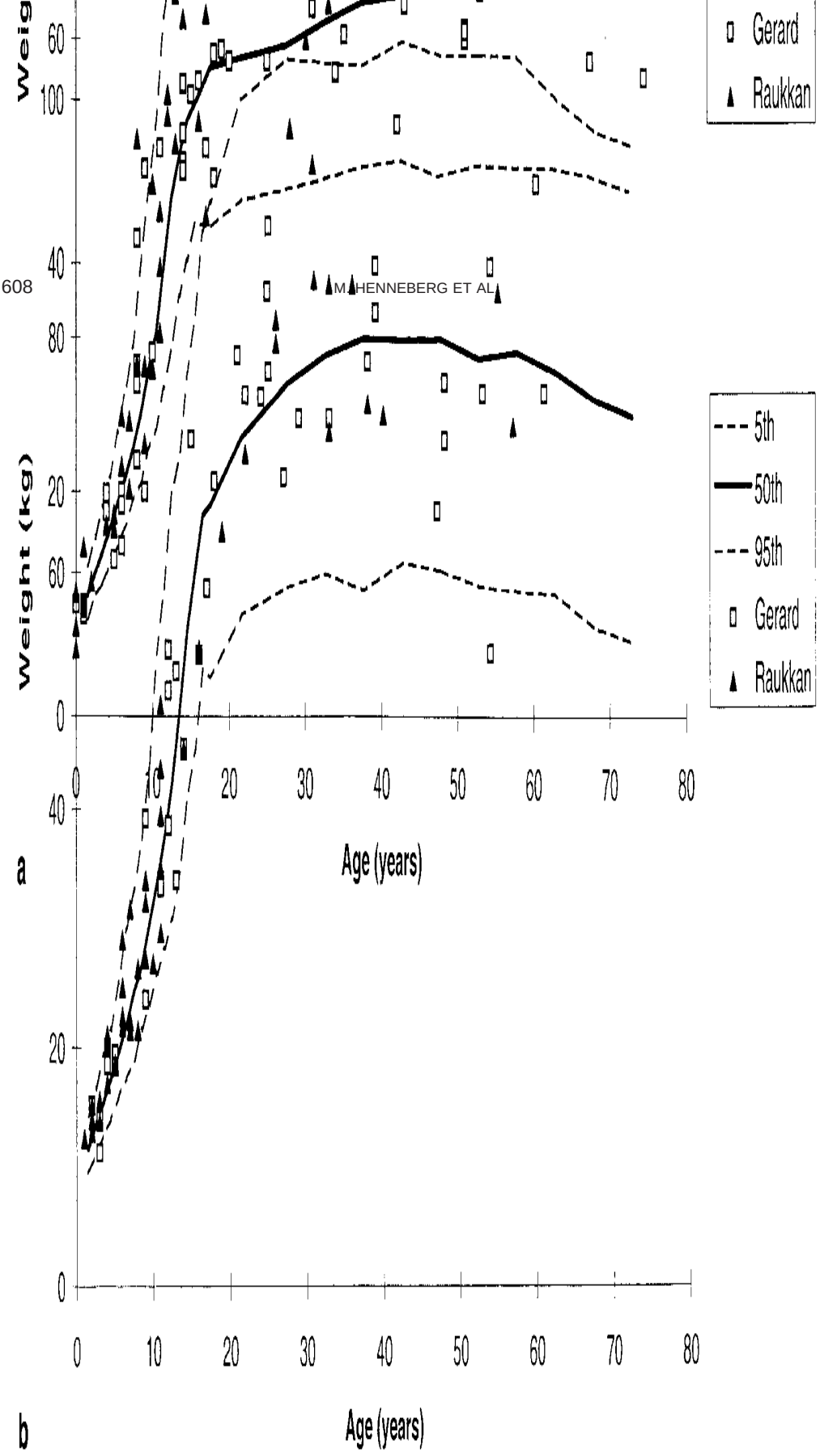


Fig. 3. Plot of weight (kg) by age for **(a)** females and **(b)** males from Gerard and Raukkan. Data are plotted against American reference (Frisancho, 1990).

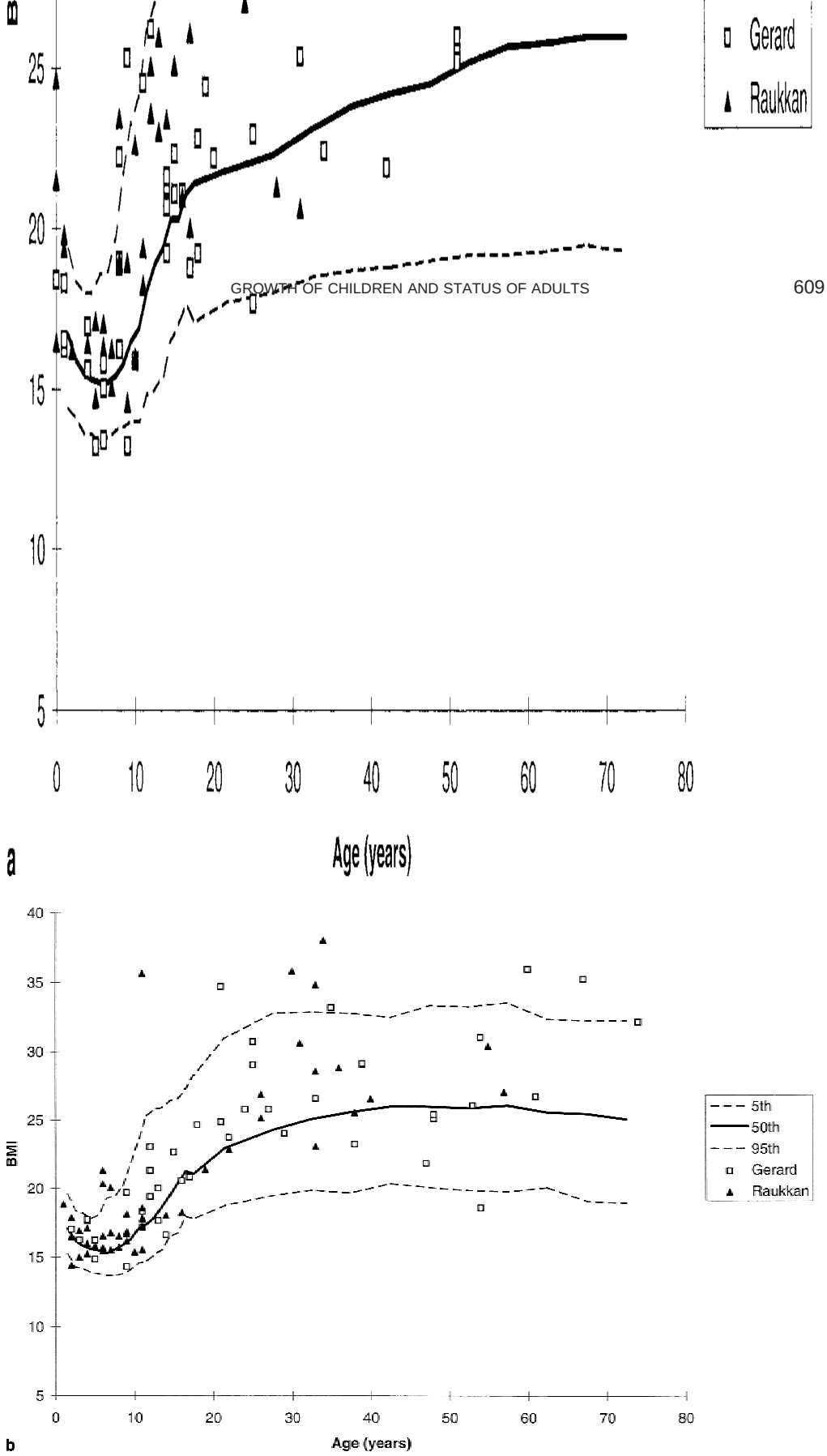


Fig. 4. Plot of BMI by age for **(a)** females and **(b)** males from Gerard and Raukkan. Data are plotted against American reference (Frisancho, 1990).

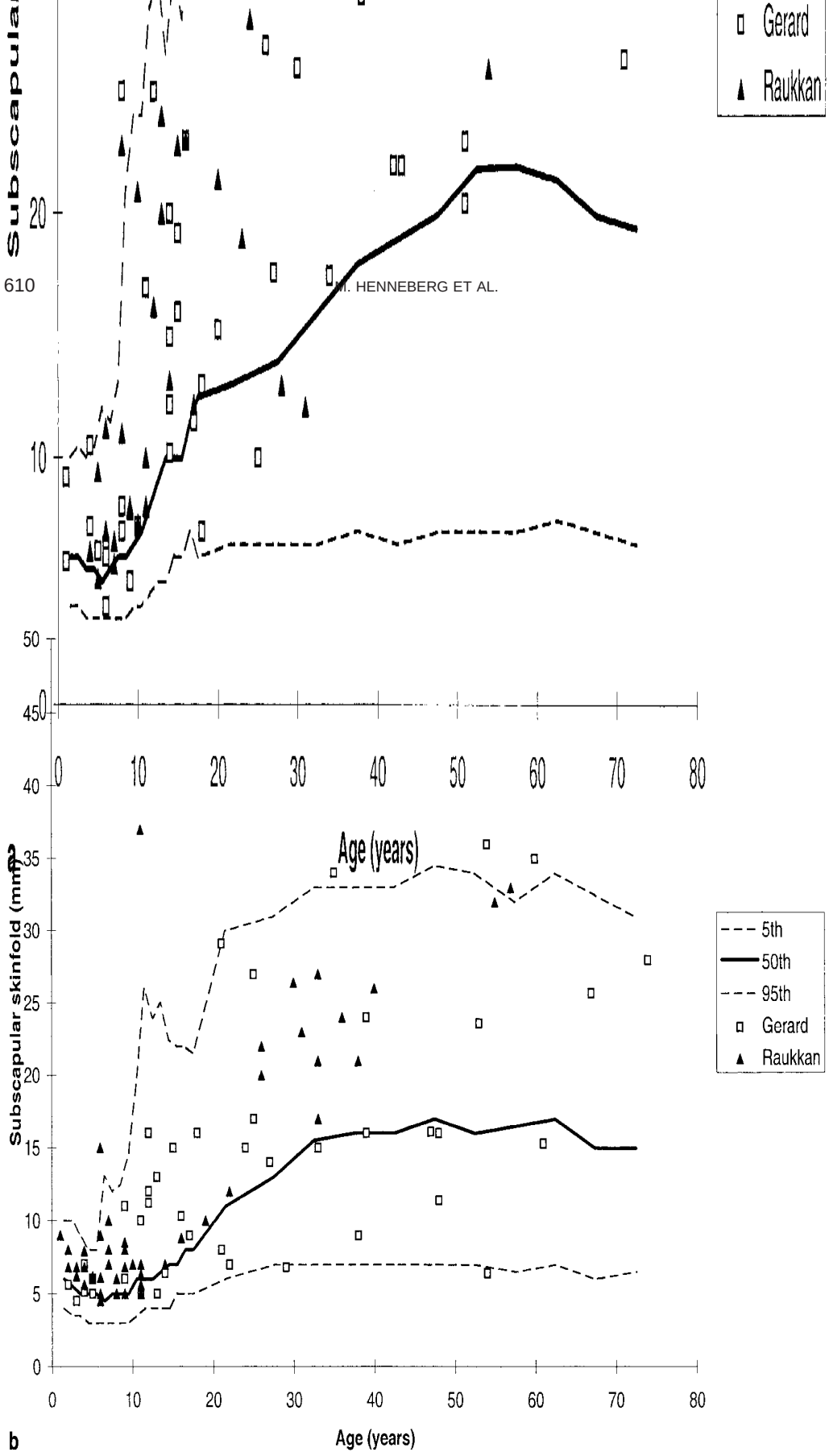


Fig. 5. Plot of subscapular skinfold thicknesses by age for **(a)** females and **(b)** males from Gerard and Raukkan. Data are plotted against American reference (Frisancho, 1990).

consistently lower in Gerard than in Raukkan. Furthermore, average body weight *z* scores in all groups from Raukkan are higher than those of inhabitants of Gerard. The *z* scores for the BMI in all groups in Gerard are lower than in Raukkan, though insignificantly so.

DISCUSSION

Because inhabitants of the studied communities are of diverse origin it is not entirely appropriate to compare results of this study with results of earlier studies that aimed to describe growth of people of exclusively Aboriginal extraction. In general, heights recorded by Abbie (1975) for Central Australian Aborigines were similar to those found in the present study and 0.5–1.0 standard deviation unit below the United States reference, while Kettle's (1966) data limited to the first five years of life indicate statures of children in Arnhem Land to be shorter than those found in this study and >1.0 standard deviation below the reference. Body weights from all previous studies (Central Australia, Abbie, 1975, and Brown and Barrett, 1971; Arnhem Land, Kettle 1966) were below (approximately 1.0 standard deviation) those in the present study, and lie close to the 5th percentile of the reference. It seems, therefore, that the main feature of inhabitants of Gerard and Raukkan is a major increase in weight but no significant alteration in stature.

The results indicate somewhat poorer physical status of inhabitants of Gerard than of Raukkan, as expected from the difference in history and the present status of the two communities. Irrespective of the slight differences, it appears that children in both communities receive abundant nutrition resulting in caloric surpluses and leading to a significantly increased BMI and fatness of the trunk, which in some cases will reach levels of obesity in adulthood, especially among women. Abundant nutrition, however, does not translate into adequate skeletal growth, especially in the subjectively poorer Gerard community. This is reflected in significantly shorter stature and less robust bones as indicated by biepicondylar breadth of the humerus. Reasons for this situation may include non-optimal composition of the diet, psychosocial stress, or disease load. Their unravelling will require further studies, necessary because the growth pattern found may lead to risk of disease and ill health in adulthood. The growth pattern and resulting obesity are characteristic for some developing countries and for groups of people of low socioeconomic status in developed countries (Sobal and Stunkard, 1988; Popkin, 1994). It seems that the physical status of people living in both studied communities fits into this category.

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