Secular trend in height in enlisted men and recruits from the Brazilian Navy born from 1970 to 1977

Tendência secular em estatura em alistados e recrutados da Marinha brasileira nascidos entre 1970 e 1977

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Abstract *This study presents data from a survey on height trends in Brazilian Navy enlisted men and recruits born from 1970 to 1977. The sample consisted of 52,574 enlisted men and 4,459 recruits ranging in age from 18.00 to 18.99 years. The statistical processing employed two-way analysis of variance procedure, simple linear regression comparing height and year of birth and multiple analysis controlling for schooling (regression coefficient) and the chi-square. The results show that enlisted men and recruits displayed height increments, characterizing a contemporary process of secular trend. Such increments were also present in the country's various macro-regions. The results were compared to a recent investigation of a national scope – the National Survey on Health and Nutrition (PNSN) – and both enlisted men and recruits displayed higher median height than that reported by the PNSN. Level of schooling for individuals in the Navy is high, far superior to that of the Brazilian population as a whole. This set of data suggests that young men enlisting in the Navy are on average of a higher socioeconomic status than the Brazilian population in general, which limits possibilities for extrapolating the findings from this research.*

Key words *Anthropometry; Nutrition; Height; Military Personnel; Epidemiology*

Resumo *Este trabalho apresenta dados de um estudo sobre a evolução da estatura em alistados e recrutas da Marinha do Brasil nascidos entre 1970 e 1977. A amostra constitui-se de 52574 alistados e 4459 recrutas com idades entre 18,00 e 18,99 anos. Na análise estatística foi utilizado o procedimento de análise de variância ("Two-way"), de regressão linear simples entre estatura e ano de nascimento e múltipla controlando para escolaridade (coeficiente angular) e o qui quadrado. Os resultados demonstram que alistados e recrutas apresentaram incrementos em estatura, caracterizando um processo contemporâneo de tendência secular. Estes incrementos também estiveram presentes nas diversas macro-regiões do país. Os resultados foram comparados a uma recente investigação de representatividade nacional – Pesquisa Nacional sobre Saúde e Nutrição (PNSN) – e tanto alistados como recrutas apresentaram médias de estatura mais elevadas que as medianas reportadas pela PNSN. O nível de escolaridade dos indivíduos da Marinha é alto e bem superior ao evidenciado para a população brasileira. Este conjunto de informações sugere que os jovens que se alistam na Marinha são em média de status sócio-econômico mais elevado se comparados a população brasileira em geral, o que limita as possibilidades de extrapolação dos achados desta investigação.*

Palavras-chave *Antropometria; Nutrição; Estatura; Pessoal Militar; Epidemiologia*

Introduction

Various studies have pointed to a trend towards increases in height in adults from developed countries since the mid-19th century (Eveleth & Tanner, 1990; Malina, 1990; Van Wieringen, 1986). This process, called secular trend, is attributed to improvements in health, social, and economic conditions. From a methodological point of view, temporal series from military data banks are among the most commonly employed sources of data for analyzing secular trends (Floud, 1984; Fogel, 1986; Fogel et al., 1982; Tanner, 1982).

Little is known about the dynamics of the secular trend process in height in developing countries, including Brazil. This fact derives more from a lack of research tradition in this field than a lack of data amenable to analysis. For example, there are still few analyses of temporal series built on the basis of military data (Figueiró, 1994; Marcondes & Marques, 1993; Paiva, 1994; Victora et al., 1989). Recently, some authors have sought to compensate for this lack of information on secular trends through analyses based on data from cross-sectional studies of a national scope (Monteiro et al., 1994, 1995). The results of such research generally point to a positive secular trend in the physical growth of Brazilians over the course of the last three decades.

This study proposes to investigate the dynamics of the secular trend in height in Brazil utilizing data banks for Navy enlisted men and recruits. We present data on individuals born from 1970 to 1977. In addition to an analysis of the secular trend *per se*, we point to some theoretical and methodological issues relating to the utilization of military data for research on secular trends.

Material and methods

The analysis was based on two computerized data banks provided by the Military Personnel Department of the Brazilian Navy, located in the city of Rio de Janeiro, including data from the enlistment and recruiting boards from the entire country. One refers to the enlisted sailors and the other to the recruits from 1990 to 1996. These bases provide personal information (date and place of birth and enlistment and recruiting districts), anthropometric data (height in centimeters), and socioeconomic data (schooling). The total number of enlisted men in all the Brazilian States with birth dates from 1970 to 1977 was 104,691, while there were 9,716 recruits born from 1971 to 1976.

As for age, the vast majority of the 104,691 records for enlisted sailors referred to individuals from 17 to 21 years of age (97.6%), with a concentration at 17 (35.8%) and 18 (50.4%) years. These data agree with the Navy's enlistment criteria, according to which boys are supposed to enlist in the year when they reach 18 years of age. In the Navy data bank there was a small percentage of individuals aged 16 years or under (0.6%), a significant portion of which is probably related to key-in errors for birth dates. There was also a low percentage of individuals 22 years of age or greater (1.6%), which probably refers to men who enlist late and individuals whose birth dates involve key-in errors. As for the 9,716 recruits, the vast majority (98.8%) were aged 18 to 20 years, with a concentration at 18 (49.7%) and 19 (45.3%) years. Only 0.2% were 17 years or less and 0.8% 21 years or more. For the purposes of our analyses, we chose to work only with individuals from 18.00 to 18.99 years of age, who made up approximately half of the cases in the data banks for both enlisted men and recruits.

One of the purposes of the investigation was to detect inter-regional differences in the mean height values and the occurrence of secular trend in enlisted men and recruits. To this end, we only kept in the data bank those individuals who were born and enlisted in the same macro-region. This procedure was meant to control insofar as possible the issue of population mobility. Of the total number of enlisted men (104,691) and recruits (9,716), use of this criterion eliminated 14,074 (13.5%) and 741 (7.6%) of the records, respectively.

The data banks for enlisted men and recruits were submitted to prior inspection in order to identify obvious measuring and key-in errors. To this end we generated graphs and identified outliers in the overall distribution. For example, in the 104,691 records of enlisted men we detected 20 with heights less than 140 cm and 47 measuring over 210 cm. Of the 9,716 recruits, 3 were less than 140 cm tall and 6 over 210 cm, in addition to 3 cases for whom this datum was not available. We assumed that both these very low and very high height values are due to key-in problems. In both data banks we opted arbitrarily to exclude height values outside the 140-210 cm interval. Next, we calculated the means and standard deviations for height [enlisted men (1970-1977): n = 52,585; x = 172.62; SD = 6.88; recruits (1971-1976): n = 4,459; x = 172.39; SD = 6.61], based on which we established intervals of ± 4 standard deviations. For enlisted men and recruits we obtained intervals of 145.1-200.1 and 145.9-198.8 cm, re-

spectively. The analyses only included values within these intervals.

After the implementation of the various criteria described above, the sample consisted of 52,574 records of enlisted men and 4,459 recruits, or 50.2% and 45.9% of the original data banks, respectively.

The only variable associated with socioeconomic conditions that was available in the data banks was schooling. This was expressed as years of schooling. For enlisted men this variable was grouped into three categories: 1-4, 5-7, and 8-11 years. The vast majority of recruits (99.6%) had 8 or more years of schooling (Table 1).

The analyses focused on comparisons of samples of enlisted men and recruits stratified by year of birth, macro-region, and schooling. The statistical procedures were performed using Epi-Info 6.02 (Dean et al., 1995) and SPSS (Marija, 1992). They included frequency analysis, goodness-of-fit χ^2, analysis of variance, and simple linear and multivariate regression analysis.

Results

We analyzed the frequency distributions for height values based on the last digit in order to check for measurement bias. We found that the values were not evenly distributed, with a concentration on 0 and 5 for both enlisted men (χ^2 = 145.8; df = 63; p = 0.00) and recruits (χ^2 = 70.18; df = 45; p = 0.01). Nevertheless, additional analyses failed to back the hypothesis that the frequencies by final digit differed over time for either enlisted men or recruits.

The vast majority of the Navy enlisted men and recruits came from the Southeast (58% of the enlisted men and 57.2% of the recruits) and Northeast (22.8% of the enlisted men and 21.7% of the recruits).

Young people enlisting in or recruited by the Navy from all the various macro-regions have high levels of schooling, the majority having gone to school for at least 8 years (91.6% of the enlisted men and 99.6% of the recruits) (Table 1). Although the majority of the enlisted men from the Southeast (85.8%) had 8 or more years

Table 1

Distribution of schooling for Navy enlisted men and recruits born from 1970 to 1977, by macro-region.

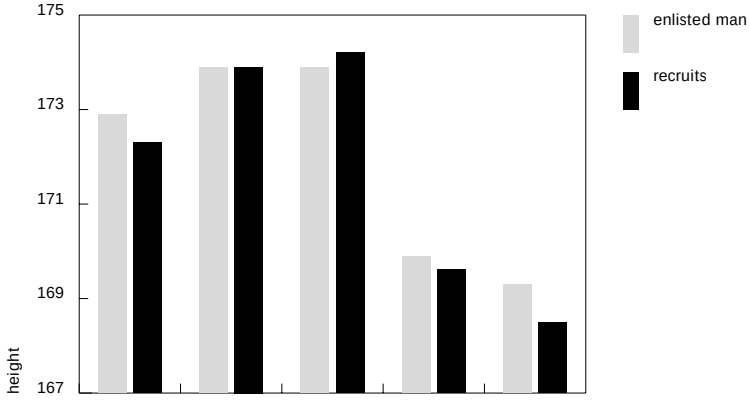
	Schooling (years of study)							
	Enlisted men				Recruits			
Region	1-4	5-7	8-11	Total	1-4	5-7	8-11	Total
South								
n	2	11	2,404	2,417	–	–	271	271
%	0.1	0.5	99.5		–	–	100.0	
Southeast								
n	1,828	2,500	26,162	30,490	8	7	2,536	2,551
%	6.0	8.2	85.8		0.3	0.3	99.4	
Central-West								
n	2	6	2,530	2,538	1	–	274	275
%	0.1	0.2	99.7		0.4	–	99.6	
Northeast								
n	23	27	11,957	12,007	1	–	966	967
%	0.2	0.2	99.6		0.1	–	99.9	
North								
n	5	9	5,103	5,117	1	–	394	395
%	0.1	0.2	99.7		0.3	–	99.7	
Brazil								
n	1,860	2,553	48,156	52,569	11	7	4,441	4,459
%	3.5	4.9	91.6		0.2	0.2	99.6	

of schooling, the percentages of those with 1-4 years (6.0%) and 5-7 years (8.2%) of schooling in this macro-region were considerably higher than in the others. As for the recruits, only 18 individuals (0.4%) had less than 8 years of schooling, the majority of whom (15) were from the Southeast. Results of the "two-way" analysis of variance confirmed not only the occurrence of statistically significant differences in schooling among the macro-regions ($F = 271.1$; 4 df; $p < 0.01$) and between enlisted men and recruits ($F = 15.0$; 1 df; $p < 0.01$), but also of interaction between these variables ($F = 15.0$; 4 df; $p < 0.01$). The study also detected (by simple regression analysis) that levels (or years) of schooling for enlisted men (regression coefficient = 0.094; $p < 0.001$) and recruits (regression coefficient = 0.112; $p < 0.001$) increase over the course of the years for Brazil as a whole.

When we compared mean years of schooling for the 1971-76 period we observed that (surprisingly) for almost all of the macro-regions the means for recruits were lower than those of enlisted men [South: 8.92 (enlisted men) vs. 8.65 (recruits); Southeast: 8.61 (enlisted men) vs. 8.67 (recruits); Central-West: 9.42 (enlisted men) vs. 8.89 (recruits); Northeast: 9.0 (enlisted men) vs. 8.58 (recruits); North: 8.21 (enlisted men) vs. 8.1 (recruits)]. Frequency analyses provided a better understanding of this finding. The lower average schooling of the recruits is not explained by the Navy systematically selecting individuals with less schooling, but by the fact that it recruits individuals with exactly 8 years of schooling, that is, with a complete primary school education. Proportionally, there are more enlisted men than recruits with 9-11 years of schooling (38.7% vs. 35.1%, respectively). While 53.3% of the enlisted men have 8 years of schooling, the proportion is 64.5% for recruits.

Figure 1

Mean height for Navy enlisted men and recruits by macro-region. Brazil, 1971-1976.

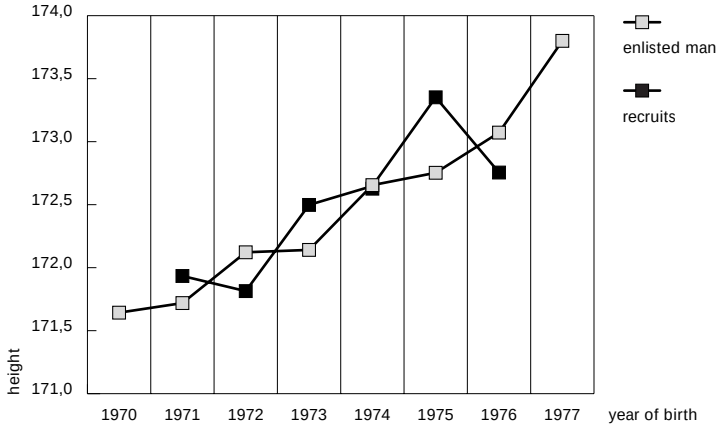


	South	Southeast	Central-West	Northeast	North
enlisted man	172,9	173,9	173,9	169,9	169,3
recruits	172,3	173,9	174,2	169,6	168,5

Figure 1 compares mean height for enlisted men and recruits by macro-region for 1971-1976. Once again, unexpectedly, mean height for enlisted men is higher than that of recruits in the majority of the macro-regions (South, Northeast, and North). Results of the "two-way" analysis of variance not only attest to statistically significant differences in height between macro-regions ($F = 1163.0$; 4 df; $p<0.01$) and between enlisted men and recruits ($F = 8.8$; 1 df; $p < 0.01$), but also to interaction between these variables ($F = 2.4$; 4 df; $p = 0.05$).

Figure 2

Evolution of mean height for Navy enlisted men and recruits by year of birth. Brazil, 1970-1977.



	1970	1971	1972	1973	1974	1975	1976	1977
enlisted man	171,643	171,719	172,122	172,141	172,655	172,753	173,072	173,8
recruits		171,934	171,814	172,498	172,648	173,352	172,755	

Figure 2 shows the height trend for enlisted men and recruits born from 1970 to 1977 in Brazil. For both groups there was a clear upward trend during the period studied. For enlisted men, the increase was some 0.3 cm per year (regression coefficient = 0.315; $p < 0.001$) and for recruits 0.2 cm/year (regression coefficient = 0.221; $p < 0.001$).

Figure 3 shows the trends for mean height for enlisted men and recruits by macro-region. The latter include data only for the Southeast and Northeast, since the samples for the other macro-regions are quite small. As for the sizes

of the mean values, two main sets stand out: one from the South, Southeast, and Central-West and the other from the North and Northeast. Height gain rates are positive and statistically significant for all the macro-regions analyzed (Table 2). Note that important proportional gains in height occurred in the North and Northeast, the country's poorest areas, but that this did not suffice to reduce the enormous inter-regional disparities. It is noteworthy that the Southeast displays the lowest gain rates. However, we note that the enlisted men and recruits from the Southeast are the ones that tend to display the highest mean height over the course of nearly the entire series (Figure 3).

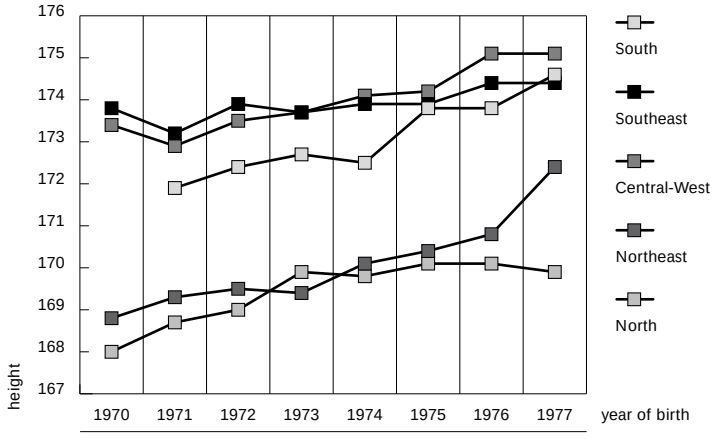
Multiple regression analyses using height as the dependent variable and years of schooling and year of birth as independent variables showed that despite a slight drop, height gain rates remained high and positive as well as statistically significant over the course of the 1970s both for enlisted men (regression coefficient = 0.266; $p < 0.001$) and recruits (regression coefficient = 0.199; $p < 0.001$) after controlling for schooling (Table 2). The adjusted coefficients for enlisted men and recruits are 16% and 10% lower than the non-adjusted ones, respectively, considering Brazil as a whole. This observation suggests that the height gain over the course of the period studied is associated partially with the enlistment and recruitment of young men who supposedly have a higher socioeconomic status (Table 2).

Table 3 presents the data on mean height by schooling for enlisted men. As expected, those with more schooling are also taller on average. Taking Brazil as a whole, simple regression analyses indicate negative regression coefficients for the samples of enlisted men with 1-4 and 5-7 years of schooling and positive ones for those with 8-11 years. Since the majority of the enlisted men with 1-7 years of schooling come from the Southeast, the negative coefficient is mainly due to the enlisted men from this region. Regression analyses by macro-region considering only enlisted men with 8-11 years of schooling due to the small size of the samples for the other schooling brackets indicate strong positive gain rates, significant at 0.01 for all of them (South: 0.455; Southeast: 0.149; Central-West: 0.479; Northeast: 0.354; North: 0.284). As for recruits, data are not presented by schooling bracket, since almost all of the individuals (99.6%) have 8 to 11 years of schooling (Table 1).

Figure 3

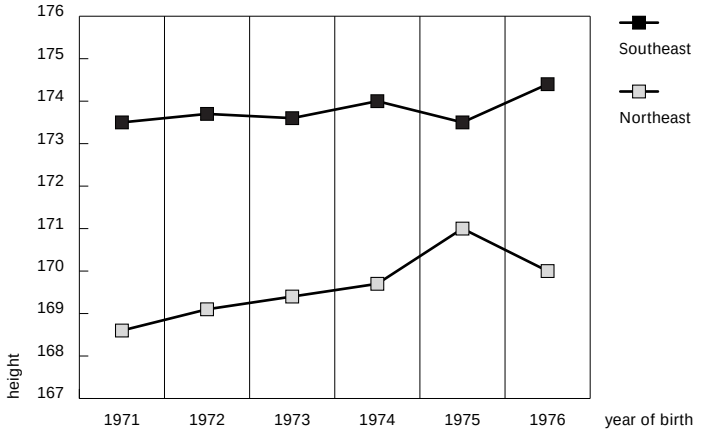
Evolution of mean height for Navy enlisted men (3a) and recruits (3b) by year of birth and macro-region. Brazil, 1970-1977.

3a



	1970	1971	1972	1973	1974	1975	1976	1977
South		171,9	172,4	172,7	172,5	173,8	173,8	174,6
Southeast	173,8	173,2	173,9	173,7	173,9	173,9	174,4	174,4
Central-West	173,4	172,9	173,5	173,7	174,1	174,2	175,1	175,1
Northeast	168,8	169,3	169,5	169,4	170,1	170,4	170,8	172,4
North	168	168,7	169	169,9	169,8	170,1	170,1	169,9

3b



	1971	1972	1973	1974	1975	1976
Southeast	173,5	173,7	173,6	174	173,5	174,4
Northeast	168,6	169,1	169,4	169,7	171	170

Table 2

Regression coefficient (B) for height over year of birth, adjusted and non-adjusted for number of years of schooling for Navy enlisted men and recruits by macro-region. Brazil, 1970-1977.

	Enlisted men		Recruits	
	B	Adjusted B	B	Adjusted B
South	0.461**	0.480**		
Southeast	0.150**	0.080**	0.146*	0.128*
Central-West	0.354**	0.353**		
Northeast	0.480**	0.461**	0.248*	0.229*
North	0.278**	0.272**		
Brazil	0.315**	0.266**	0.221**	0.199**

B: Regression coefficient for height and year of birth
Adjusted B: Regression coefficient adjusted for schooling
* p<0.05
** p<0.01

Discussion

Use of anthropometric data from military institutions requires special care *vis-à-vis* the occurrence of bias, mainly measurement and selection bias. For example, Fogel et al. (1983) report a higher frequency of even figures (55%) in North American and English data banks. According to the same authors, accumulation of even figures is common even when measurements are taken by skilled personnel, and simulation models indicate that such accumulation introduces small errors in estimates of mean height. In the case of the Navy data reported in this study, we detected a 55% frequency of even values; in addition, there is a clear accumulation of height values ending in 0 and 5. However, the proportions remained relatively constant throughout the period studied. Such constancy allows one to suppose that the results pertaining to the occurrence of a secular trend were not distorted by the presence of such a bias. We will return to the issue of selection bias later.

Analyses of secular height trends for Brazil are still rare, including those based on military data banks (Figueiró, 1994; Marcondes & Marques, 1993; Paiva, 1994; Victora et al., 1989). All point to the occurrence of a positive trend in samples over recent years or recent decades, depending on the respective study's temporal depth. We reached a similar conclusion based on our analysis of Navy data banks. Despite the short time interval for which data were available (6-7 years), there is unequivocal evidence of a strong secular trend for Brazil as a whole, with a gain of 0.315 cm/year for enlisted men and 0.221 cm/year for recruits born in the 1970s. Observed in this decade was that even with an increase in concentration of income, the *per capita* Gross Domestic Product increased 81%, the percentage of the population living in absolute poverty decreased by more than half, and essential services like running water, sewerage, immunization coverage, and medical care improved (Monteiro et al., 1993, 1994). Note that analyses indicated that the secular trend was associated with level of schooling, where individuals with more schooling displayed positive gain rates. Despite the fact that a directly proportional relationship between schooling and a secular trend was expected, it is unusual to detect a negative trend in enlisted men with 1-7 years of schooling. One cannot exclude the possibility of this negative trend being due to random fluctuations in mean height rather than to a downward trend *per se*. As compared to individuals with 8-11 years of schooling, amongst whom there is a clear, linear, upward trend, for those from the other schooling brackets one notes variations over the course of the period studied. Based on this notion it might be more prudent to conclude that the upward height trend in the stratum with more schooling is not observed in those with less schooling.

Analyses of military anthropometric data banks generally aim to shed light on the occurrence of secular trends for the overall population from which the enlisted men and recruits come. In the case of Brazil, where enlistment is mandatory for men, the initial premise is that the Armed Forces data banks can be used to detect the occurrence of a secular trend for the country as a whole. Thus emerges an important theoretical and methodological question: is it possible to extrapolate from the results of Navy enlisted men and recruits to the overall Brazilian population? We will attempt to answer this question based on the information for schooling and height available in the Navy data bank.

First, level of schooling for young men serving in the Navy is high. We found that the vast majority (91.6%) of the enlisted men had at least eight years of schooling (i.e., had finished primary school). This is one aspect that distinguishes them from the overall Brazilian population, in which only 26.7% had finished primary school in 1991 (IBGE, 1994, Table 2,109). Another characteristic indicating the uniqueness of the Navy enlisted men and recruits is height itself. Comparison of the results of analyses conducted on the basis of the Navy data bank and those of the National Survey on Health and Nutrition (PNSN) held in 1989 (INAN, 1990)

Table 3

Evolution of mean height for Navy enlisted men by year of birth and level of schooling. Brazil, 1970-1977.

	Years of schooling								
	1-4 years			5-7 years			8-11 years		
Year	n	Mean	SD	n	Mean	SD	n	Mean	SD
1970	–	–	–	–	–	–	321	171.6	6.8
1971	90	169.7	7.3	91	171.8	6.5	3,321	171.8	6.7
1972	275	169.6	6.4	319	171.1	6.5	8,371	172.2	6.9
1973	470	170.4	6.4	624	171.3	6.7	9,294	172.3	6.8
1974	432	169.5	6.2	603	171.1	6.6	7,707	172.9	6.9
1975	312	168.7	6.5	493	170.1	6.9	6,073	173.1	6.7
1976	184	168.5	7.1	254	170.7	6.4	6,149	173.3	6.9
1977	97	170.1	6.6	165	170.3	6.5	6,920	173.9	6.8
B		-0.226			-0.196			0.337	
p value		0.0242			0.0250			0.000	

B: Regression coefficient.

sheds light on several points. Individuals 18 years of age that were measured by the PNSN are part of the 1971 birth cohort, that is, they can be compared to the enlisted men and recruits from that same year. Overall median height for Brazil was 169.8 cm, thus almost 2 centimeters less than the estimated median for Navy enlisted men (171.0 cm) and recruits (172.0 cm) who were also born in 1971. When we compare the figures by macro-region, median height in the Navy was systematically higher than that obtained by the PNSN. Finally, Navy recruits are also taller on average than men opting for the Army. For example, median height levels for sailors born in the States of Rio de Janeiro (172.7cm) and Pará (167.3 cm) in 1971 were greater than those for Army soldiers born in those same States in the same year (171.0 and 165.3 cm, respectively) (Marcondes & Marques, 1993). This set of information suggests that, based on schooling and height, young men serving in the Navy have a higher socioeconomic status than the Brazilian population as a whole. They thus constitute a clearly differentiated group within the national population.

Even while displaying characteristics that distinguish them unequivocally from the overall Brazilian population, the Navy data reflect certain well-known characteristics for the country. For example, they point to a marked inter-regional differentiation, with the South, Southeast, and Central-West displaying significantly higher mean height figures than those for the Northeast and North. A similar pattern was detected by the PNSN for children, youth, and adults (INAN, 1990). In addition, based on the Navy data it was possible to reveal the occurrence of a strong secular trend, which is backed by analyses of various other data banks, both military and non-military, as mentioned earlier.

The simultaneous availability of data banks for enlisted men and recruits provided us with a unique opportunity, i.e., to check which criteria orient the choice of youth who are about to be incorporated into military service. Here lies a particularly interesting point in this investigation: the Navy does not necessarily incorporate taller or more educated individuals, as one might deduce based on common sense. As for the former criterion, for the majority of the regions the mean height of recruits is lower than that of enlisted men. As for the latter, enlisted men had a higher mean years of schooling than recruits. Not that the Navy focuses systematically on recruiting individuals with less education; on the contrary, rarely are individuals with less than 8 years of schooling recruited. The reason for the difference detected is that there is a preference for recruiting individuals into the Navy who have precisely a complete primary school education. We should recall that 18-year-olds with 8 years of schooling have an educational level short of what is possible, since they are old enough to have finished secondary school (11 years of schooling). Apparently the Navy tends to recruit more of those individuals that have up to a complete primary school education than those who are in secondary school (with 9 and 11 years of schooling).

If indeed Navy enlisted men form a population sample with quite peculiar anthropometric and educational characteristics, the recruits

constitute an even more special set. What are the implications of these observations with regard to the utilization of one or the other in secular trend studies? In Brazil, for example, studies by Marcondes & Marques (1993) and Victora et al. (1989) were based on data banks for Army recruits. Judging by our study's findings, conclusions based on analyses of data banks for Navy enlisted men and recruits could hardly be extrapolated to the Brazilian population as a whole, the less so for recruits.

Based on this study's results we conclude that height or schooling are not the only or main criteria determining whether an individual will or will not be recruited by the Navy. Floud (1984) and Tanner (1981), among others, state that recruiting in Europe and the United States traditionally used to favor taller individuals. Recruiting criteria currently used by the Brazilian Navy differ from this pattern. There are certainly important criteria orienting the choice of recruits (history of disease, overall physical health, visual impairment, dental status, etc.) which unfortunately cannot be explored on the basis of the data banks analyzed in our research. That is, the data are lacking to analyze selection criteria in greater depth.

In conclusion, our results demonstrate that the secular height trend phenomenon is present in the samples studied and that the cohort with more schooling, which has a higher socioeconomic status, displays progressively greater mean height levels. It was also shown that conclusions concerning secular trend based on Navy data cannot be extrapolated directly to the Brazilian population in general, since the enlisted men and recruits display anthropometric and socioeconomic characteristics that distinguish them sharply from the general population.

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