PHYSICAL FITNESS IN A SUBMARINE COMMUNITY AS DETERMINED BY THE U.S. NAVY HEALTH AND PHYSICAL READINESS TEST

LT B. L. Bennett, MSC, USN

Naval Submarine Medical Research Laboratory
Box 900, Naval Submarine Base New London
Groton, CT 06349-5900

APPROVED AND RELEASED BY:

C. A. Harvey

C. A. HARVEY, CAPT, MC, USN
Commanding Officer
Naval Submarine Medical Research Laboratory

SUMMARY PAGE

PROBLEM

For many years undersea medical officers and scientists have postulated that submarine personnel assigned to sea duty have a greater need to be aware of their lifestyle at sea. Long term confinement, physical inactivity, potential for excessive caloric intake, large consumption of coffee, higher incidence of cigarette smoking and an altered work/rest cycle can rapidly lead to decreased physical and mental performance. Therefore, the purpose of this study was to compare the results from the Health and Physical Readiness (H&PR) test between submarine personnel assigned to sea duty and personnel assigned to shore duty.

FINDINGS

The results from the annual (H&PR) test showed that submarine personnel are of equal fitness compared to shore based personnel. In fact, the submarine personnel outperformed the shore personnel in many fitness categories. The majority of personnel in both groups were classified as "good" which is an average level of physical fitness. One percent of the personnel in each group scored "outstanding" on the H&PR test, and approximately ten percent of personnel in each group failed to meet the minimum requirements. A body fat value $\geq$ 22 percent was the reason for the majority of failures.

APPLICATION

Because of the constant need for methods to increase military readiness, Navy commanders should be aware of the current physical fitness levels of their personnel. A greater commitment to physical training is necessary to increase the current level of physical fitness. Structuring weekly training programs during deployment and while at shore duty will enable naval personnel to perform their duties, especially during critical, long term, stressful, emergency scenarios without showing major decrements in job performance.

ADMINISTRATIVE INFORMATION

This investigation was conducted as part of Naval Medical Research and Development Command Work Unit - 62758N MF58.524.003-0004 "Enhancement of Physical and Mental Performance in Submariners Through the Promotion of Increased Fitness and Health." The manuscript was submitted for review on 07 MAR 1986, approved for publication on 06 MAY 1986, and designated as NSMRL Laboratory Report No. 1074.

PUBLISHED BY THE NAVAL SUBMARINE MEDICAL RESEARCH LABORATORY

ABSTRACT

This study was conducted to test the hypothesis that personnel assigned to submarine duty would dispaly less physical fitness as compared to shore based personnel. A message was submitted to all naval activities at a Naval Submarine Base requesting individual test scores from the annual Health and Physical Readiness (H&PR) Test. The results from the statistical analysis showed that the majority of personnel in both populations were classified as "good", which is an average level of physical fitness as determined by the navy's fitness classification table. One percent of both populations were classifed as "outstanding" and approximately ten percent failed to meet the minimum physical fitness requirements. A body fat value greater than 22 percent was the cause for the majority of test failures. In conclusion, the results of the analysis of H&PR data do not support the widely held belief that submarine personnel are less physically fit then their shore based counterparts.

Physical fitness in the U.S. Armed Services has always played a dominate role in the preparation of personnel for military readiness. Type and intensity of physical training depends on which branch of service an individual is affiliated. The Navy Department has traditionally emphasized physical fitness at its training centers, but there is a decreased emphasis on physical conditioning as one transfers into the fleet. During this time, and for the most part, throughout a military career, routine physical conditioning is left up to the discretion of the individual. Futhermore, the lack of an on-going, well implemented physical fitness program in the navy has caused many personnel to develop a complacent attitude towards physical fitness training.

Based on a 1981 Department of Defense Directive on physical fitness and weight control(3), the Navy Department has taken initial steps in health promotion by establishing the Office of Health and Physical Readiness. Subsequently this office has developed the Health and Physical Readiness (H&PR) test as discussed in the Chief of Naval Operations Instruction (OPNAVINST), 6110.1b (19). This instruction encompasses a "wellness" approach to preventive medicine by including physical training primarily by aerobic activities, nutrition, weight control, avoidance of drug/alcohol abuse, stress management, high blood pressure control and smoking cessation. The success of this program at the command level primarily depends on the designated "command fitness coordinator". This position, typically assigned as a collateral duty, should ideally be assigned to an individual with appropriate background training and interest. It is ultimately important to have ship and shore commanders educated as to the potential benefits to be derived from these programs. These benefits include an increase in self-esteem, weight control, improved physical fitness, reduced medical cost, enhanced job performance, and augmented military readiness (1,2,5,14,24).

For many years, undersea medical officers and scientists have postulated that submarine personnel have a greater need to be aware of their lifestyle at sea. Long term confinement, physical inactivity, potential for excessive caloric intake, large consumption of coffee, higher incidence of cigarette smoking and an altered work/rest cycle (4,21,23,24) can rapidly lead to decreased physical and mental performance (5,6,16). Some myths, such as the belief that submarine crews gain excessive weight while on patrol, have been stated when extrapolation of this lifestyle is attempted. Bondi and Beare (7) reported results on pre- and post-deployment body weights on 670 submarine personnel from seven different submarine patrols and showed that 32 percent of the crew gained weight on the average of 5 lbs./person, whereas, 56 percent lost weight on the average of 5 lbs./ person. The average overall weight change following these submarine patrols was a loss of 2.68 lbs. per man. Although the authors stated that substantial weight gain ($\geq$ 10 lbs) does afflict a number of the men, it was concluded that weight gain during patrol is not a significant problem for the majority of submariners.

Physiological adaptations to physical inactivity are known to occur, for example, from prolonged bed rest (20) and from reduced levels of physical training (11). Physical deconditioning has been purported to occur in submarine personnel from prolonged exposure to the submarine environment. Bennett and Bondi (5) have reviewed the field study research that have attempted to measure physical deconditioning in submariners. The physiological indicator of deconditioning in these studies was a progressive increase in post exercise heart rate measured throughout the deployment as a sign of cardiovascular compensation to maintain cardiac output (9). Bondi and Dougherty (8) monitored the physical activity of 44 submariners at sea as determined by the use of pedometry. Results indicated that daily physical activity was reduced by 50 percent when compared to daily activities when the submariners were shore based. Subsequent research by Knight et al (16) and more recently by Bennett et al (6) have quantified laboratory measures of physiological deconditioning following submarine deployment. These authors (16,6) reported a 13 and an 8 percent decrement in maximal oxygen uptake ($\dot{V}O_2$ max) as measured by pre and post deployment levels of $\dot{V}O_2$ max. To date no other fitness indicators have been assessed in submarine personnel to determine whether a decrement occurs in muscular strength, muscular power, agility, or flexibility.

Since the Navy has now established the H&PR test as a criterion for physical fitness, it was the purpose of this study to compare the H&PR results of submarine personnel assigned to sea duty with naval personnel assigned to shore duty. The distinction between personnel assigned to sea duty commands versus shore based commands was made due to the uniquely different daily lifestyle habits. Additionally, submarine personnel typically are deployed at sea between 70 and 180 days depending on the operational assignments and type of submarine duty (fleet ballistic missile or fast attack submarine). Therefore, the hypothesis was that submarine personnel would show significantly less physical fitness as determined by the H&PR test when compared to their shore based counterparts.

METHODS

This study was conducted by submitting an all Naval Activities (NAVACTS) message to individual commands in and around the Naval Submarine Base, Groton, Connecticut. The message requested that individual scores from the Health and Physical Readiness Test be sent to the Naval Submarine Medical Research Laboratory, Biomedical Sciences Department, Naval Submarine Base. These data included: command name, rate/rank, age, sex, test scores for the 1.5 mile run or 500 yard swim, sit-ups, sit reach, percent body fat, and the individual and overall test classifications. Each subject had the option to participate in the 1.5 mile run or the 500 yard swim. Height and weight measurements were an option to be included if they were available. The specific protocol for the administration of each test variable can be found in OPNAVINST 6110.1B (19).

The following procedures determined how an individual was given an overall test classification from the results of each test variable. Subjects scored points for each test item performed with the exception of the sit-reach test which was scored pass/fail. The classification point values were as follows: outstanding - 5 points., excellent - 4 points., good - 3 points., satisfactory - 2 points., minimum - 1 point. Unsatisfactory score on any test variable constitutes an overall test failure. The three scored sections (1.5 mile run or 500 yard swim, sit-ups, and percent body fat) were averaged to determine the overall test classification. To score an outstanding classification, all test variables must be scored outstanding. An average score with X.5 or more was rounded up except for excellent and any score below X.5 is rounded down except for minimum. See table 1 for the test requirements and physical readiness classifications.

The first age group (17-29 years) as established in the OPNAVINST 6110.1B instruction (19) is for individuals less than thirty years old. It was suspected that a significant difference in physical performance exists within this age group, therefore three distinct age groups ($\leq$ 19, 20-24, 25-29 years) were developed for individuals under thirty years old. All subjects within these three age groups had their overall test classification scored by the same criterion based on the first age group in table 1.

Field data were verified for the correct calculation of individual and overall test classifications before the raw scores were entered into a computer file through a VT-100 Digital terminal. Data were separated and analyzed for submarine and shore commands by five year age groups, starting with $\leq$ 19 years old and ending with $\geq$ 45 years old. Univariate statistics and the independent t-test were applied to the data by the use of the User's Guide to the Conversational System (SCSS), Trademarks of Statistical Package for the Social Sciences (18), on a Vax 11/7050, Digital Corporation. The ($p<0.05$) level of probability was used as the criterion for rejecting the null hypothesis.

RESULTS

A total of 5409 male test respondents were analyzed from 20 submarine and 19 shore commands. There were no significant differences in age, height, weight and percent body fat between submarine and shore commands (table 2). Since the submission of height and weight values were optional, only 548 subjects reported these physical descriptors. Interestingly, only 25 subjects chose the 500 yard swim versus the 1.5 mile run and because of this small number, further analysis will not be included.

Test results (means $\pm$ SD) for the submarine commands were: 1.5 mile run: 11:58 $\pm$ 1:58 minutes; sit-ups: 51.82 $\pm$ 16.75; body fat: 15.87 $\pm$ 4.91 percent; and sit-reach: 98.3 percent passed. The shore commands had very similar values: 1.5 mile run: 12:36 $\pm$ 1:58 minutes; sit-ups: 52.49 $\pm$ 16.79; body fat: 15.88 $\pm$ 4.89 percent; and sit-reach: 96.2 percent passed. See table 3a and 3b for the test results by age groups for the submarine and shore commands.

The greatest percentage of personnel in submarine commands (37.6 percent) were classified as good on the overall test; 9.4 percent of the subjects scored unsatisfactory, and 0.9 percent of all the personnel scored outstanding. See table 4a for the breakdown of each test variable by test classification for each age group. The shore commands closely resembled the submarine commands in the overall test classifications. Nearly the same percentage of subjects from the shore commands (33.8 percent) were classified as good; 10.6 percent scored unsatisfactory, and again only 0.9 percent scored outstanding. Table 4b shows the breakdown of test variable classification by age group.

The mean values for the 1.5 mile run time of all the age groups were entered into a regression equation (run time=27.48 - 0.357x, where x=$\dot{V}O_2$ max; Thomas R. Collingwood, Ph.D., Institute for Aerobic Research, personal communication). This equation was developed from data collected on U.S. Air Force personnel by Copper (10) to predict maximal consumption ($\dot{V}O_2$ max) from the 1.5 mile run times. The $\dot{V}O_2$ max values for the submarine personnel ranged from 34.0 ml kg^{-1} min^{-1} to 46.0 ml kg^{-1} min^{-1}. The highest and lowest $\dot{V}O_2$ max values corresponded with youngest and oldest age groups, respectively. This inversely proportional relationship also existed for the shore personnel; whose values ranged from 37.0 ml kg^{-1} min^{-1} to 44 ml kg^{-1} min^{-1}. The grand mean for all age groups for $\dot{V}O_2$ max was 43.5 ml kg^{-1} min^{-1} and 41.0 ml kg^{-1} min^{-1} for the submarine and shore personnel, respectively.

There were significant differences between submarine and shore personnel when age groups for each variable were considered (see table 5). Submarine personnel ran significantly ($p<0.05$) faster than the shore personnel on the 1.5 mile test for the second through fifth age groups (20-39 yrs.), and for the total mean run time. The shore personnel, however, performed a significantly ($p<0.05$) higher number of sit-ups than their counterparts for the second, third and fourth age groups. Furthermore, the submarine personnel had significantly ($p<0.05$) greater percent of body fat for the second age group; no other age groups were significantly different for this test variable.

DISCUSSION

The results from the present study do not support the widely held belief that submarine personnel are less physically fit than their shore based counterparts. On the contrary, submarine personnel outperformed the shore personnel in some tests, specifically, submarine personnel ran significantly faster in five of seven age groups on the 1.5 mile run. Furthermore, submarine personnel ran faster by 38 seconds than the shore population when all age groups were collapsed into a total mean. The majority of subjects' scores in both groups were distributed between the satisfactory and excellent classifications, whereas the highest percentage of subjects in both groups were classified as good on the overall H&PR test. It was surprising however, to see that less than one percent of subjects in both groups were classified as outstanding. Conversely, approximately ten percent in each group were classified as unsatisfactory. The primary reason that subjects received an unsatisfactory classification on the overall test was due to a failure to meet the 22 percent body fat requirement.

The American Heart Association (AHA) has published values for cardiovascular fitness based on a maximal oxygen uptake test for all age groups(13). When the predicted maximal oxygen uptake values determined from the 1.5 mile data are compared to the AHA values, the submarine personnel were classified as good across all age groups. The shore personnel were also classified as good for the first two and the last two age groups. The three middle age groups of the shore personnel were classified as average in cardiovascular fitness. These estimated maximal oxygen consumption values for both groups are comparable to the direct laboratory measurement of $\dot{V}O_2$ max in 14 submarine personnel ranging in age from 20-39 years as reported by Bennett et al (6).

The shore personnel performed more sit-ups in four age groups, with three age groups performing a statistically greater number of sit-ups than the submarine personnel. As with the 1.5 mile run, the greatest percentage of subjects in both groups scored good on this test variable. Nice et al (17) reported a mean score of 47.8 $\pm$ 16.7 sit-ups for male naval personnel. While this value is comparable to the total mean values for this study, the submarine and shore personnel scored slightly higher values.

Recently the sit-reach test was changed from a scaled measure, (plus or minus in inches away from the heel of the feet), to a pass/fail criterion: touch your toes to pass, anything less constitutes a failure of this test. Data on this test indicates that the current method is not specific for the assessment of flexibility as originally developed. Less than three percent of all subjects failed.

The submarine personnel had slightly greater percent body fat values than the shore based personnel in five of seven categories, although these data were not statistically significant. The distribution of data were skewed towards lower percent body fat in both groups and the greatest percentage of subjects were classified as outstanding. Based on the current measurement technique (26) used by the Navy to estimate the percentage of body fat, 35.9 percent and 38.8 percent of the shore and submarine personnel were measured at 14 percent body fat or less. However, a substantial number of subjects were greater than 22 percent body fat resulting in an unsatisfactory classification for 6.4 percent of the shore personnel and 7.7 percent of the submarine personnel. The low failure rate is considerably less than the 14.3 percent failures as cited by Nice et al(17) and the 15.8 percent predicted failure to meet the minimum body fat requirement as reported by Hodgdon and Marcinik (15). While a reasonable amount of variability in this measurement technique can be expected between naval commands, it has been well accepted and also found to be reliable (17,26). Data from this group of subjects corroborated the findings of Hodgdon and Marcinik (15) who reported body fat values to be 16.1$\pm$5.5 percent for 67 submarine personnel (24.6$\pm$5.2 years). These data also corroborate the findings of Bondi and Dougherty (7), that submarine personnel do not gain body fat during submarine deployment. Futhermore, these values reflect a lower than average percent body fat for males of the same age group in general population (12).

With the recent development and limited application of this instruction (OPNAVINST 6110.1b) (19) since its implementation in 1982, the question of test data reliability within and between naval commands warrants discussion. There are numerous potential sources of error which will account for a portion of the variability of the data. The greatest source of error probably occurs from administration of the test procedures by the command fitness coordinator. Even though the instruction attempts to provide a detailed description of the methods to correctly administer each test variable, it can logically be assumed that a reasonable amount of "hands-on" experience is necessary to correctly administer these procedures. Another source of error is in the transfer of raw scores to be converted for the calculation of the overall test classification (17).

Since Nice et al (17) examined test reliability on the H&PR test, the following summary of their key results is presented here for a clarification of inter-command data collection accuracy: Test reliability was investigated as part of their study to determine whether there were large measurement differences between command fitness coordinators versus trained technicians on these testing procedures. One of the contributing sources of error by numerous commands was quantifying the 1.5 mile course. These course lengths ranged from 315 feet less to 294 feet greater than the required 1.5 mile distance. However, the run times collected by the trained technicians and by command fitness coordinators revealed a high degree of accuracy (r=0.98). Furthermore, in all cases submitted, 90 percent of the raw scores were transformed correctly to the appropriate test classification. The largest discrepancy noted in the sit-up test was the inconsistency in the correct body position during the two minute period. It was shown that 96 percent of sit-up classification was correctly computed. The overall reliability of body fat measurement, between the command fitness coordinator and trained personnel, revealed a correlation of r=0.84 which was noted to be a satisfactory level of reliability for field measures. The calculations of body fat values as determined by the command fitness coordinators were compared to computer generated values, and these values revealed a high accuracy calculation rate with a correlation of r=0.97. The sit-reach method will not be discussed since the method used for the study by Nice et al (17) had changed by the time of this study's data collection. Finally, it was noted that the accuracy for calculating the overall test classification was correctly determined for 79 percent of the scores, with 88 percent of the errors benefiting the test subjects' classification.

SUMMARY AND RECOMMENDATIONS

The belief that submarine personnel are less physically fit as compared to non-submarine personnel has been suspected by many individuals who have been closely associated with submarine way of life. Based on the Navy's H&PR test for the assessment of physical abilities commonly associated with physical fitness, the submarine personnel showed no major decrements in physical fitness as compared to shore based personnel. Moreover, the majority of both populations displayed an average physical fitness level as determined by the fitness classification table, and by the AHA standards for cardiovascular fitness.

The Health and Physical Readiness test may be strengthened and be made more valuable to naval personnel if the following recommendation are considered: 1) test requirements should reflect a certain level of necessary weekly physical training to meet the minimum test requirements; 2) future addendums to the OPNAVINST instruction should provide specific methods for proper and more accurate test administration, and provide motivational techniques for greater personnel adherence/compliance for physical training and for performing at the classification levels of excellent or outstanding; 3) the flexibility test should return to a graded measurement scale, -- the current test does not assess flexibility, due to the low failure rate; 4) an upper-body strength test should be added to the future instruction because the majority of strength requirements at sea are derived from the upper body; 5) these particular H&PR test variables should reflect the physical attributes that are associated with specific ship and shore strength requirements; 6) development of H&PR computer software programs for navy wide distribution would facilitate the calculation of test classifications, thus minimizing any variability associated with raw data transformations; and 7) specific navy medical research and development laboratories should be tasked to develop and maintain H&PR test data collected from warfare specialties (i.e., submarine, air and surface), thus determining whether naval personnel are homogeneous in the level of physical readiness and whether there are specific physical training requirements necessary for maintaining military readiness.

REFERENCES

1. American College of Sports Medicine. Position statement on proper and improper weight loss programs. Med. Sci. Sports and Exer. 1983; 15(1):ix-xii.

2. American College of Sports Medicine. Position statement on the recommended quantity and quality of exercise for developing and maintaining fitness in healthy adults. Med. Sci. Sports. 1978; 10(3):vii-v.

3. ASD(MRA&L), Physical fitness and weight control programs. Department of Defense Directive, No. 1308.1, 29 June 1981.

4. Beare AR, Biersner RJ, Bondi KR, Naitoh P. Work and rest on nuclear submarines. Ergonomics 1981; 24:593-610.

5. Bennett BL, Bondi KR. The relationship of job performance to physical fitness. Naval Submarine Medical Research Laboratory Report #962, 1981. (DTIC A108198)

6. Bennett BL, Schlichting CL, Bondi KR. Cardiorespiratory fitness and cognitive performance before and after confinement in a nuclear submarine. Aviat. Space Environ. Med. 1985; 56:1085-91.

7. Bondi KR, Beare AR. Body weight changes before and after submarine patrols. Naval Submarine Medical Research Laboratory Report #1062, 1985. (DTIC A161-144)

8. Bondi KR, Dougherty JH. Physical activity aboard a nuclear submarine as measured by pedometry. Naval Submarine Medical Research Laboratory Report #1053, 1985. (DTIC A159231)

9. Clausen JP. Effect of physical training on cardiovascular adjustments to exercise in man. Physiol. Rev. 1977; 57:779-814.

10. Copper KH. Testing and developing cardiovascular fitness within the United States Air Force. J. Occup. Med. 1968; 10:636-639.

11. Coyle EF, Martin WH, Sinacore DR, Joyner MJ, Hagberg JM, Holloszy JO. Time course of loss of adaptation after stopping prolonged intense endurance training. J. Appl. Physiol. 1984; 57:1857-64.

12. Durnin JVGA, Wommersley J. Body fat assessed from total body density and its estimation from skinfold thickness: measurement on 481 men and women aged from 16 to 72 years. Br. J. Nutr. 1974; 32:77-97.

13. Exercise Testing and Training of Apparently Healthy Individuals: A Handbook for Physicians. The Committee on Exercise, American Heart Association, 1972.

14. Folkins CH, Sime WE. Physical fitness training and mental health. Am. Psychol. 1981; 36:373-89.

15. Hodgdon JA, Marcinik EJ. A survey of body fat content of U.S. Navy personnel. Naval Health Research Center, Report #83-4, 1983.

16. Knight DR, Bondi KR, Dougherty JH, Shamrell TP, Younkin RK, Wray DD, Mooney LW. The effects of occupational exposure to nuclear submarines on human tolerance for exercise. Fed. Proc. 1981; 40:497 (Part 1, Abstract No. 1516).

17. Nice DS, Dutton L, Seymour GE. An analysis of baseline navy health and physical readiness data from local shore facilities. Naval Health Research Center, Report #85-1, 1985.

18. Nie NH, Hull CH, Franklin MN, Jenkins JG, Sours KJ, Norusis MJ, Beadle V. A user's guide to the SCSS conversational system. McGraw-Hill Co., New York, 1980.

19. NMPC-6H. Health and physical readiness program. Chief of Naval Operation Instruction 6110.1B, Department of the Navy, 19 OCT 1981.

20. Saltin B, Blomqvist G, Mitchell JH, Johnson R, Wildenthal K, Chapman CB. Response to exercise after bed rest and after training. Circulation, 1968; 37(5) (Suppl. 7):1-78.

21. Schaefer KE, Kerr CM, Buss D, Haus E. Effect of 18-h watch schedules on circadian cycles of physiological function during submarine patrols. Undersea Biomed. Res. Suppl. 1979; 6:s81-90.

22. Sonstroem RJ. Exercise and self-esteem. In: Terjung RL, ed. Exercise and Sport Sciences Reviews. V. 12, Lexington: Collamore Press, 1984:123-56.

23. Tappan DV, Mooney LW, Jacey MJ, Heyder E. Cardiovascular risk factors in submariners. Undersea Biomed. Res. Suppl. 1979; 6:s201-216.

24. Weybrew BB, Molish HB. Attitude changes during and after long submarine missions. Undersea Biomed. Res. Suppl. 1979; 6:s175-190.

25. Wilmore JH, Davis JA. Validation of a physical abilities field test for the selection of state traffic officers. J. Occup. Med., 1979; 21:33-40.

26. Wright HF, Dotson CO, Davis PO. A simple technique for measurement of percent of body fat in man. U.S. Navy Med, 1981; 72:23-27.

ACKNOWLEDGEMENTS

The author wishes to thank HM2 C. Perry, USN for technical assistance in the study. I thank CDR K.R. Bondi, MSC, USN for the conscientious review of the manuscript, and Mrs. J. McNary for preparing the manuscript.

Table 1: PHYSICAL READINESS CLASSIFICATION TABLE AND TEST REQUIREMENTS*

AGE (YRS.)	<30	30-34	35-39	40-44	45-49	≥ 50
OUTSTANDING						
1.5 MILE RUN	9:45	10:00	10:30	11:00	11:30	12:00
500 YARD SWIM	8:00	8:30	9:00	9:30	10:00	10:30
SIT - UPS	100	90	75	80	80	80
SIT REACH	PASS	PASS	PASS	PASS	PASS	PASS
PERCENT FAT	14	14	14	14	14	14
EXCELLENT						
1.5 MILE RUN	10:45	11:00	11:30	12:00	12:30	13:00
500 YARD SWIM	9:45	10:15	10:45	11:15	11:45	12:15
SIT - UPS	75	68	64	60	60	60
SIT REACH	PASS	PASS	PASS	PASS	PASS	PASS
PERCENT FAT	16	16	16	16	16	16
GOOD						
1.5 MILE RUN	13:00	14:00	14:30	15:00	15:30	16:00
500 YARD SWIM	11:30	12:00	12:30	13:00	13:30	14:00
SIT - UPS	50	45	43	40	40	40
SIT REACH	PASS	PASS	PASS	PASS	PASS	PASS
PERCENT FAT	18	18	18	18	18	18
SATISFACTORY						
1.5 MILE RUN	14:30	15:30	16:00	16:30	17:00	17:30
500 YARD SWIM	13:15	13:45	14:15	15:45	16:15	16:45
SIT - UPS	36	34	32	30	30	30
SIT REACH	PASS	PASS	PASS	PASS	PASS	PASS
PERCENT FAT	20	20	20	20	20	20
MINIMUM						
1.5 MILE RUN	15:00	16:00	16:30	17:00	17:30	18:00
500 YARD SWIM	15:00	15:30	16:00	16:30	17:00	17:30
SIT - UPS	33	31	29	27	27	27
SIT REACH	PASS	PASS	PASS	PASS	PASS	PASS
PERCENT FAT	22	22	22	22	22	22

* subjects must exceed the listed value to score the next highest classification. 1.5 mile run and 500 yard swim are in min. and sec.

TABLE 2: CHARACTERISTICS OF PERSONNEL FROM SUBMARINE AND SHORE COMMANDS.

VARIABLE	SUBMARINE COMMANDS	SHORE COMMANDS
Number of Subjects	2346	3063
Number of Commands	20	19
Medical Waivers	12 (0.5%)	66 (2.2%)
Age (yrs.)	25.64 $\pm$ 5.30	27.52 $\pm$ 6.60
Height (in.)*	70.78 $\pm$ 2.45	69.21 $\pm$ 3.11
Weight (lbs.)*	177.86 $\pm$ 28.15	173.03 $\pm$ 29.85
Percent body Fat	15.87 $\pm$ 4.91	15.88 $\pm$ 4.89

* = 202 subjects from the submarine and 346 subjects from the shore commands for height and weight. Values for age, height, weight, and percent body fat are means and standard deviations.

Table 3a: PHYSICAL READINESS VALUES FOR SUBMARINE COMMANDS BY AGE GROUPS

AGES (yrs.)	≤ 19	20-24	25-29	30-34	35-39	40-44	≥45	TOTALS
SUBMARINE COMMANDS								
1.5 mile run								
mean	11:22	11:40	12:02	12:26	13:06	13:28	14:12	11:58
s.d.	±1:41	±1:51	±1:48	±1:57	±2:06	±2:11	±2:03	±1:58
n	74	1178	562	277	143	36	8	2279
SIT-UPS								
mean	54.77	54.25	51.70	46.30	44.70	42.55	40.63	51.82
s.d.	±16.23	±17.30	±15.97	±14.62	±13.72	±15.93	±18.01	±16.75
n	74	1196	573	282	146	38	8	2318
SIT-REACH								
pass	74	1188	571	281	145	38	8	2306
fail	0	8	4	0	1	0	0	13
% BODY FAT								
mean	13.88	15.03	16.38	17.31	18.25	18.70	16.50	15.87
s.d.	±4.40	±4.91	±4.83	±4.33	±4.63	±4.46	±4.35	±4.91
n	76	1207	581	285	146	40	8	2345

Table 3b: PHYSICAL READINESS VALUES FOR SHORE COMMANDS BY AGES GROUPS

AGES (yrs.)	≤ 19	20-24	25-29	30-34	35-39	40-44	≥45	TOTAL
SHORE COMMANDS								
1.5 mile run								
mean	11:44	12:03	12:34	13:15	13:36	13:25	13:26	12:36
s.d.	±1:43	±1:50	±1:48	±1:59	±1:59	±2:18	±2:14	±1:58
n	200	983	872	416	359	107	36	2975
SIT-UPS								
mean	54.28	57.20	54.21	48.52	43.56	41.04	43.83	52.49
s.d.	±14.33	±17.22	±17.09	±14.43	±12.42	±15.21	±13.38	±16.79
n	202	991	883	423	368	113	41	3022
SIT REACH								
pass	199	969	865	410	357	104	41	2947
fail	3	20	17	14	10	11	0	75
% BODY FAT								
mean	13.57	14.53	15.97	17.40	17.94	17.38	19.57	15.88
s.d.	±4.57	±4.87	±4.75	±4.55	±4.36	±4.16	±4.76	±4.89
n	199	965	863	412	363	116	42	2961

Table 4a: PHYSICAL READINESS TEST CLASSIFICATIONS AND AGE GROUPS
(submarine commands)

AGE (YRS.)	≤ 19	(%)	20-24	(%)	25-29	(%)	30-34	(%)	35-39	(%)	40-44	(%)	≥ 45	(%)	TOTAL	(%)
1.5 MILE RUN																
Unsatisfactory	1	(1.4)	9	(0.8)	13	(2.3)	4	(1.4)	5	(3.4)	0	(0)	0	(0)	32	(1.4)
Minimum	2	(2.7)	76	(6.4)	39	(6.9)	11	(4.0)	7	(4.8)	2	(5.6)	0	(0)	137	(5.8)
Satisfactory	8	(10.8)	226	(19.1)	137	(24.2)	51	(18.3)	21	(14.5)	10	(27.8)	3	(37.5)	456	(19.4)
Good	37	(50.0)	460	(38.8)	228	(40.3)	136	(48.9)	30	(55.2)	16	(44.4)	3	(37.5)	960	(40.9)
Excellent	13	(17.6)	280	(17.5)	82	(14.5)	45	(16.2)	16	(11.0)	3	(8.3)	1	(12.5)	369	(15.7)
Outstanding	13	(17.6)	207	(17.5)	67	(11.8)	31	(11.2)	16	(11.0)	5	(13.9)	1	(12.5)	340	(14.5)
SIT-UPS																
Unsatisfactory	0	(0)	8	(0.7)	1	(0.2)	1	(0.4)	0	(0)	0	(0)	0	(0)	10	(0.4)
Minimum	10	(13.2)	196	(16.4)	109	(19.1)	43	(15.2)	24	(16.4)	7	(18.4)	1	(12.5)	390	(16.6)
Satisfactory	17	(22.4)	276	(23.1)	148	(25.9)	112	(39.7)	50	(34.2)	9	(23.7)	5	(62.5)	618	(26.3)
Good	36	(47.4)	529	(44.3)	243	(42.5)	94	(33.3)	60	(41.1)	17	(44.7)	1	(12.5)	980	(41.8)
Excellent	10	(13.2)	162	(13.6)	66	(11.5)	27	(9.6)	10	(6.8)	4	(10.5)	0	(0)	279	(11.9)
Outstanding	1	(1.3)	24	(2.0)	5	(0.9)	5	(1.8)	2	(1.4)	1	(2.6)	1	(12.5)	39	(1.7)
% Body FAT																
Unsatisfactory	2	(2.6)	80	(6.6)	49	(8.4)	29	(10.2)	15	(10.3)	5	(12.5)	0	(0)	180	(7.7)
Minimum	5	(6.6)	101	(8.4)	64	(11.0)	51	(17.9)	29	(19.9)	8	(20.0)	2	(25.0)	260	(11.1)
Satisfactory	5	(6.6)	139	(11.5)	91	(15.7)	40	(14.0)	36	(24.7)	8	(20.0)	1	(12.5)	320	(13.6)
Good	11	(14.5)	143	(11.8)	92	(15.8)	52	(18.2)	23	(15.8)	8	(20.0)	2	(25.0)	331	(14.1)
Excellent	8	(10.5)	172	(14.3)	97	(16.7)	44	(15.4)	18	(12.3)	4	(10.0)	0	(0)	343	(14.6)
Outstanding	45	(59.2)	572	(47.4)	188	(32.4)	69	(24.2)	25	(17.1)	7	(17.5)	3	(37.5)	910	(38.8)
OVERALL CLASSIFICATION																
Unsatisfactory	5	(6.6)	99	(8.2)	64	(11.1)	31	(11.0)	19	(13.0)	3	(8.3)	0	(0)	221	(9.4)
Minimum	0	(0)	22	(1.8)	10	(1.7)	13	(4.6)	2	(1.4)	3	(8.3)	0	(0)	50	(2.1)
Satisfactory	5	(6.6)	188	(15.7)	132	(22.8)	65	(23.1)	39	(26.7)	11	(30.6)	5	(62.5)	445	(19.0)
Good	32	(42.1)	432	(36.0)	222	(38.4)	119	(42.3)	64	(43.8)	12	(33.3)	1	(12.5)	882	(37.6)
Excellent	34	(44.7)	448	(37.3)	147	(25.4)	49	(17.4)	22	(15.1)	6	(16.7)	1	(12.5)	708	(30.2)
Outstanding	0	(0)	12	(1.0)	3	(0.5)	4	(1.4)	0	(0)	1	(2.8)	1	(12.5)	21	(0.9)

Table 4b: PHYSICAL READINESS TEST CLASSIFICATIONS AND AGE GROUPS
(shore commands)

AGE (yrs.)	≤ 19	(%)	20-24	(%)	25-29	(%)	30-34	(%)	35-39	(%)	40-44	(%)	≥45	(%)	Total	(%)
1.5 MILE RUN																
Unsatisfactory	5	(2.5)	16	(1.6)	31	(3.6)	9	(2.2)	8	(2.2)	2	(1.9)	0	(0)	71	(2.3)
Minimum	4	(2.0)	64	(6.5)	84	(9.6)	36	(8.6)	26	(7.2)	9	(8.4)	1	(2.8)	224	(7.3)
Satisfactory	31	(15.5)	211	(21.5)	253	(29.0)	127	(30.5)	92	(25.5)	17	(15.9)	8	(22.2)	739	(24.1)
Good	92	(46.0)	426	(43.5)	350	(40.1)	181	(43.4)	185	(51.2)	46	(43.0)	14	(38.9)	1294	(42.2)
Excellent	49	(24.5)	149	(15.2)	94	(10.8)	36	(8.6)	21	(5.8)	14	(13.1)	5	(13.9)	369	(12.0)
Outstanding	19	(9.5)	114	(11.6)	60	(6.9)	28	(6.7)	29	(8.0)	19	(17.8)	8	(22.2)	279	(9.0)
SIT-UPS																
Unsatisfactory	0	(0)	0	(0)	5	(0.6)	2	(0.5)	5	(1.4)	1	(0.9)	0	(0)	13	(0.4)
Minimum	24	(11.9)	80	(8.0)	101	(11.4)	48	(11.3)	52	(14.1)	28	(24.8)	6	(14.6)	339	(11.1)
Satisfactory	48	(23.8)	231	(23.2)	251	(28.4)	138	(32.6)	136	(37.0)	32	(28.3)	10	(24.4)	846	(27.6)
Good	106	(52.5)	515	(51.7)	415	(47.0)	186	(44.0)	146	(39.7)	36	(31.9)	17	(41.5)	1421	(46.4)
Excellent	23	(11.4)	135	(13.6)	84	(9.5)	41	(9.7)	26	(7.1)	13	(11.5)	8	(19.5)	331	(10.8)
Outstanding	1	(0.5)	30	(3.0)	27	(3.1)	8	(1.9)	3	(0.8)	3	(2.7)	0	(0)	72	(2.4)
% BODY FAT																
Unsatisfactory	8	(4.0)	53	(5.5)	55	(6.4)	34	(8.3)	33	(9.1)	5	(4.3)	8	(19.0)	196	(6.4)
Minimum	6	(3.0)	69	(7.1)	112	(13.0)	78	(18.9)	73	(20.1)	29	(25.0)	9	(21.4)	376	(12.3)
Satisfactory	20	(9.9)	84	(8.7)	118	(13.7)	76	(18.4)	69	(19.0)	19	(16.4)	9	(21.4)	395	(12.9)
Good	21	(10.4)	123	(12.7)	135	(15.6)	70	(17.0)	70	(19.3)	23	(19.8)	9	(21.4)	451	(14.7)
Excellent	29	(14.4)	147	(15.2)	131	(15.2)	63	(15.3)	59	(16.3)	13	(11.2)	3	(7.1)	445	(14.5)
Outstanding	115	(56.9)	491	(50.8)	312	(36.2)	91	(22.1)	59	(16.3)	27	(23.3)	4	(9.5)	1109	(35.9)
OVERALL CLASSIFICATION																
Unsatisfactory	17	(8.5)	85	(8.9)	96	(11.2)	53	(13.1)	50	(14.0)	15	(14.2)	9	(22.5)	325	(10.6)
Minimum	3	(1.5)	12	(1.3)	24	(2.8)	12	(3.0)	14	(3.9)	2	(1.9)	1	(2.5)	68	(2.2)
Satisfactory	15	(7.5)	124	(12.9)	213	(24.8)	131	(32.3)	105	(29.5)	39	(36.8)	9	(22.5)	636	(20.8)
Good	79	(39.7)	353	(36.8)	304	(35.4)	122	(30.1)	139	(39.0)	24	(22.6)	13	(32.5)	1035	(33.8)
Excellent	84	(42.2)	374	(39.0)	211	(24.6)	84	(20.7)	47	(13.2)	25	(23.6)	8	(20.0)	834	(27.2)
Outstanding	1	(0.5)	11	(1.1)	11	(1.3)	3	(0.7)	1	(0.3)	1	(0.9)	0	(0)	28	(0.9)

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER REPORT 1074	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) PHYSICAL FITNESS IN A SUBMARINE COMMUNITY AS DETERMINED BY THE U.S. NAVY HEALTH AND PHYSICAL READINESS TEST		5. TYPE OF REPORT & PERIOD COVERED Interim report 6. PERFORMING ORG. REPORT NUMBER NSMRL Report 1074
7. AUTHOR(s) BENNETT, B. L., Lt, MSC, USN		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Submarine Medical Research Laboratory Box 900, Naval Submarine Base New London Groton, CT 06349-5900		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS MF58.524.003-0004
11. CONTROLLING OFFICE NAME AND ADDRESS Same		12. REPORT DATE 6 MAY 1986 13. NUMBER OF PAGES 16
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Nav Med Rsch & Dev Command Naval Medical Command, National Capital Region Bethesda, MD 20814		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Exercise; Endurance; Deconditioning; Submariners

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The purpose of this study was to test the hypothesis that personnel assigned to submarine duty would display less physical fitness capacity as compared to shore based personnel. The Navy's Health and Physical Readiness Test (H&PR) was used to test this hypothesis. The distinction between these two groups of personnel was made due to the uniquely different daily life-styles/habits exhibited while at sea and at shore duty. A message was submitted to all naval activities in and around the Naval Submarine Base,

Groton, Connecticut. The message requested individual test scores on the H&PR test be sent to the Naval Submarine Medical Research Laboratory for statistical analysis. Thirty-nine commands responded with 5409 test respondents from 20 shore and 19 submarine commands.

The results of the analysis of H&PR data do not support the widely held belief that submarine personnel are less physically fit than their shore based counterparts. In fact, the submarine personnel outperformed the shore personnel in many categories. The most surprising difference between the two groups was in the 1.5 mile run, in which the submarine personnel ran statistically faster in five of the seven age categories, and ran 38 seconds faster than the shore personnel when all age categories were collapsed into a grand mean. Furthermore, the majority of personnel in both populations were classified as "good", which is an average level of physical fitness as determined by the navy's fitness classification table. One percent of both populations was classified as "outstanding" in physical fitness, and approximately ten percent failed to meet the minimum physical fitness requirements. The majority of personnel failing the test showed a body fat value greater than 22 percent.

In conclusion, the submarine personnel assigned to sea duty do not show an unusual performance on the H&PR test as compared to a shore based population. The overall fitness level in both groups should not be accepted as status quo, and command physical fitness coordinators should be challenged to augment the current level of physical fitness by structuring weekly fitness programs. The ultimate outcome of increased physical fitness will support the main peacetime objective of increased military readiness.