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Original Article

Occupational health concerns: An analysis of physical activity of submariners

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ABSTRACT

Background: Submarine crew have low physical activity by virtue of their professional requirements. Lack of space and inadequacy of regeneration capabilities render physical activity almost impossible during deployments. However, sufficient data for physical activity levels and trends are required to measure the magnitude of inactivity.

Methods: Data was collected from 362 personnel belonging to six submarines and one submarine base using Global Physical Activity Questionnaire. Four study groups were defined: Base, Refit, Operational/Harbour and Operational/Sea.

Results: Overall, 30.11% of the crew had insufficient physical activity (4.04% in Base, 5.75% in Refit, 15% in Ops/Harbour and 91.67% in Ops/Sea groups). Of the total physical activity, 48.7% was contributed by activity at work, 18.71% by travel related activity and 32.62% by recreational physical activity. Base group recorded the highest recreational activity of 1468.28 Minutes-per-Week. Recreational activity contributed 43.22% to total physical activity for this group. Mean total physical activity was highest for ≥45 years and lowest for ≤24 years. ≥45 years old also recorded the highest recreational activity.

Conclusion: The greatest cause for concern comes from the crew in operational submarines and the younger crew. Physical activity profile of the crew when at sea cannot be changed and greater research is required to assess the long-term health effects of physical inactivity in this group. However, what can be modified are the work schedules for refit submarines and operational submarines when in harbour. Targeted interventions and strategies are required to establish sustainable behaviour patterns with regards to physical activity in these groups.

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Introduction

Physical inactivity has attracted a lot of concern due to increased incidences of non-communicable diseases. In 2009, physical inactivity was identified as the fourth leading risk factor and along with tobacco smoking a behavioural risk factor for non-communicable diseases and accounted for more than 3 million preventable deaths.¹ In 2012, Lancet highlighted the global health concerns due to physical inactivity. The studies revealed that 31.1% of adults worldwide are physically inactive and 80.3% of adolescents do fewer than 60 min of moderate to vigorous intensity physical activity per day.² The studies also revealed that a third of adults do not reach public health guidelines for recommended levels of physical activity. Data from India estimated that 12.7% of male population and 18.4% of female population (with an average of 15.6% of both sexes) are insufficiently active.³

Apart from concerns regarding physical inactivity related to sedentary lifestyles globally, attention has also been focussed on certain occupational groups who may have low physical activity by virtue of their profession. Submariners are one such group who are exposed to long periods of physical inactivity during deployments. Lack of space and inadequacy of regeneration capabilities render physical activity almost impossible. The situation is particularly worrisome for conventional diesel-electric submarines compared to the larger nuclear-powered submarines.⁴

However, for submariners, the physical inactivity has not been evaluated by many studies. Sufficient data is required to measure the magnitude of inactivity, and then implement effective programmes for better health and prevention of non-communicable diseases in this occupational category.

Material and methods

Study design

A cross-sectional surveillance study was conducted and data was collected from 362 personnel belonging to six randomly selected submarines and one submarine base including both officers and sailors. Individuals were asked to volunteer for the study and all participants were randomly selected on the basis of their availability on the days of recording of data. All crew in low medical category were excluded from the study. All non-submarine-cadre personnel posted to the submarine base were also excluded.

Four study groups were defined: Group 1 comprised individuals posted to the submarine base (referred hereafter as the 'Base group') and Group 2 comprised submarines in refit (called 'Refit group'). Groups 3 and 4 comprised individuals posted to operational submarines with data being collected for the period while in harbour and when at sea respectively (called 'Ops/Harbour group' and 'Ops/Sea group'). Because of the relative similarity in their working schedules compared to the Ops/Sea group, the three groups Base, Refit and Ops/Harbour were sometimes together referred to as Non-Sea groups for some comparisons and data analyses.

Data collection and analysis

The Global Physical Activity Questionnaire (GPAQ) version 2.0 was used for data collection which is a self-reported questionnaire comprising of 16 questions developed by the World Health Organization (WHO) for physical activity surveillance. GPAQ assesses the frequency (days) and time (min/h) spent in doing moderate- and vigorous-intensity physical activity during a typical week in three domains: work-related, transport-related, and recreational physical activity.⁵ GPAQ has been validated and widely employed to assess physical activity patterns. Previous studies have shown that GPAQ has good test-retest repeatability and relative validity⁶⁻⁸ and has been used by the WHO in 122 countries as part of the STEPS programme.^{3,5}

No changes were made to the original questionnaire and data collection was done with personal interviews. Study requirements were explained to all participating individuals and GPAQ data was collected in accordance with the method standardised by the WHO. Participants were asked to report any physical activity lasting more than 10 min carried out in a typical week in all three domains. All the questionnaires were manually cleaned to remove any invalid responses, over reporting of physical activity and implausible values prior to entering data into the final data sheet. Statistical analysis was carried out using Epi Info software developed by the WHO and Microsoft Excel. ANOVA and chi-square tests were used for analysis and $P < 0.05$ was taken as significant.

Definitions

Energy expenditure was estimated based on duration, intensity and frequency of physical activity performed in a typical week. The unit of measurement for energy expenditure was metabolic equivalent (MET) derived from activity variables of the GPAQ. MET is the ratio of specific physical activity metabolic rates to the resting metabolic rate. One MET is equal to the energy cost of sitting quietly (1 kcal/kg body weight/h) and oxygen uptake in ml/kg/min with one MET is equal to the oxygen cost of sitting quietly (about 3.5 ml/kg/min). MET values and formulas for computation were based on the intensity of specific physical activity. Moderate-intensity activities during work, transportation and leisure were assigned a value of 4 METs and Vigorous intensity activities assigned 8 METs. Total physical activity score was the sum of all METs-Minutes-per-Week derived from moderate-to-vigorous-intensity physical activity performed in work, transportation and recreation.⁵

Physical activity was classified into three levels: High, Moderate and Low in accordance with the GPAQ analysis framework.⁵ These three groupings were then categorised into 'Sufficiently Active' or 'Insufficiently Active' groups. The 'Sufficiently Active' group included participants who met the physical activity recommendations, therefore, classified as being in the High or Moderate physical activity levels.⁷

Results

Data was collected from 362 male individuals belonging to the four study groups, including 26 officers with mean age of 29.35

and 336 sailors with mean age of 31.14. Average age of the study population was 31.01 years. 226 individuals belonged to the 25–34 age groups, which also formed the largest group.

Total physical activity

Table 1 shows physical activity data across study groups, rank categories and age groups for total physical activity and activity in all three domains in METs-Minutes-per-Week. Average total physical activity of the entire crew was 512.00 Minutes-per-Week contributing to 2545.53 METs-Minutes-per-Week. Amongst the four study groups, mean total physical activity was lowest in the Ops/Sea group ($P = 0.000$) compared to the three Non-Sea groups. However, it was not significantly different within the three Non-Sea groups.

Table 2 shows distribution of crew as per levels of activity within study groups, rank categories and age groups. Overall, 30.11% of the crew had insufficient physical activity and 69.89% had sufficient physical activity (48.9% High and 20.99% Moderate activity levels). The major contribution to the physically inactive population was from the Ops/Sea group within which 91.7% individuals had low physical activity. Only

3.13% and 5.21% of crew in this group had High and Moderate levels of activity respectively. Amongst the Non-Sea groups, Base and Refit groups had only 4.04% and 5.75% crew, respectively, with low physical activity compared to Ops/Harbour group in which 15% crew had low physical activity ($P = 0.008$).

Comparing domain-wise physical activity in METs-Minutes-per-Week, it was seen that of the total physical activity of the study population, 48.7% was contributed by activity at work, 18.71% by travel related activity and 32.62% by recreational physical activity.

Physical activity at work

Highest activity at work was recorded by Refit and Ops/Harbour groups (1766.67 and 1590.75 METs-Minutes-per-Week respectively). There was statistical significance between work-activity in all the four study groups, but the difference within the three Non-Sea groups was not statistically significant. Activity at work contributed to 41.7% of all activity for the Base group, 51.7% for Refit group, 48.9% for the Ops/Harbour group and 100% for the Ops/Sea group.

Table 1 – Physical activity in METs-Minutes-per-Week: Mean (SD).

Category	Physical activity domains			Total activity
	Work	Transport	Recreational	
Total	1238.23 (1404.82)	476.19 (683.85)	830.11 (1059.49)	2544.53 (2261.36)
Study groups				
Base	1417.17 (1411.68)	511.72 (593.36)	1468.28 (1189.36)	3397.17 (1949.75)
Refit	1766.67 (1326.62)	683.45 (666.97)	969.43 (1061.68)	3419.54 (1916.49)
Ops/Harbour	1590.75 (1584.16)	778.25 (893.92)	885.00 (880.61)	3254.00 (2372.78)
Ops/Sea	281.04 (666.23)	0 (0)	0 (0)	281.04 (666.23)
P value [†]	0.000	0.000	0.000	0.000
P value [‡]	0.257	0.042	0.000	0.855
Rank				
Officer	392.30 (515.36)	102.30 (210.47)	1912.31 (1592.62)	2405.92 (1787.521)
Sailor	1303.69 (1430.74)	505.12 (699.24)	746.37 (960.42)	2555.17 (2295.779)
P value [†]	0.001	0.004	0.000	0.748
Age groups				
≤24	866.94 (1333.50)	318.78 (527.42)	546.53 (873.24)	1732.24 (2176.51)
25–34	1269.20 (1432.89)	506.64 (731.63)	832.04 (1055.34)	2607.88 (2301.26)
35–44	1507.27 (1449.37)	476.06 (656.47)	840.30 (1075.39)	2823.64 (2224.74)
≥45	925.71 (859.40)	516.19 (527.20)	1439.05 (1247.49)	2880.95 (1797.97)
P value [†]	0.0715	0.3753	0.0145	0.0459

[†] ANOVA: All four study groups.

[‡] ANOVA: Non-Sea study groups.

Table 2 – Percentage of crew performing different levels of activity: % (95% CI).

Category	Level of activity		
	Sufficiently active		Insufficiently active
	High	Moderate	Low
Total	48.9 (43.65–54.17)	20.99 (16.99–25.63)	30.11 (25.48–35.17)
<i>Study groups</i>			
Base	69.67 (59.65–78.53)	26.26 (17.93–36.07)	4.04 (1.11–10.02)
Refit	73.56 (63.02–82.45)	20.69 (12.75–30.71)	5.75 (1.89–12.90)
Ops/Harbour	51.25 (39.81–62.59)	33.75 (23.55–45.19)	15 (8.00–24.74)
Ops/Sea	3.13 (0.65–8.86)	5.21 (1.71–11.74)	91.67 (84.24–96.33)
P value = 0.000 [†] P value = 0.008 [‡]			
<i>Rank</i>			
Officer	57.69 (36.92–76.65)	23.08 (8.97–43.65)	19.23 (6.55–39.35)
Sailor	48.21 (42.78–53.69)	20.83 (16.70–25.65)	30.95 (26.11–36.24)
P value = 0.449 [†]			
<i>Age groups</i>			
≤24	32.65 (19.95–47.54)	22.45 (11.77–36.62)	44.90 (30.67–59.77)
25–34	50.44 (43.73–57.14)	19.03 (14.13–24.76)	30.53 (24.60–36.98)
35–44	53.03 (40.34–65.44)	24.24 (14.54–36.36)	22.73 (13.31–34.70)
≥45	57.14 (34.02–78.18)	28.57 (11.28–52.18)	14.29 (3.05–36.34)
P value = 0.083 [†]			

[†] Chi-square test: All four study groups.

[‡] Chi-square test: Non-Sea groups.

Active transportation

Nil transport-related physical activity was recorded by the Ops/Sea group. Amongst the Non-Sea groups, the Ops/Harbour group had the highest transport-related activity (778.25 METs-Minutes-per-Week, $P = 0.042$). Contribution of transport-activity towards overall physical activity was also highest for this group (23.92%).

Recreational activity

Ops/Sea group had nil recreational activity. Base group recorded the highest recreational activity of 1168.28 METs-Minutes-per-Week compared to 969.43 METs-Minutes-per-Week for Refit group and 885.00 METs-Minutes-per-Week for the Ops/Harbour group ($P = 0.000$). This statistic was visible in the relative values also where recreational activity contributed 43.22% to total physical activity for the Base group.

Activity by rank categorisation

Rank categorisation was done between officers and sailors. It was seen that though total physical activity levels were

comparable (2405.92 and 2555.17 METs-Minutes-per-Week for officers and sailors respectively), $P = 0.748$ (Table 1), officers had significantly higher recreational activity ($P = 0.000$) compared to sailors who had higher transport-related ($P = 0.004$) and work-related ($P = 0.001$) activity. Recreational activity, in fact, contributed to 79.45% of total activity for officers. Distribution of officers and sailors as per level of activity did not show any statistical significance (Table 2), but officers had highest number of individuals performing no work-or-transport-related activity compared to sailors who had more number of individuals performing no recreational activity (Table 3).

Activity by age groups

Comparison by age groups revealed that mean total physical activity was highest for age group ≥45 years (2880.95 METs-Minutes-per-Week) and lowest for age group ≤24 years (1732.24 METs-Minutes-per-Week) with a statistically significant P value of 0.0459. Crew in the ≥45 year age group also recorded the highest recreational activity (1439.05 METs-Minutes-per-Week, $P = 0.0145$). Recreational activity, in fact, contributed 49.95% towards total activity for this age group.

Table 3 – Percentage of crew doing no work-transport-or-recreational physical activity: % (95% CI).

Category	Work (N = 108)	Transport (N = 181)	Recreational (N = 148)
Total	29.83 (25.22–34.88)	50.00 (44.74–55.26)	40.88 (35.81–46.16)
<i>Study groups</i>			
Base	10.10 (4.95–17.79)	41.41 (31.60–51.76)	8.08 (3.55–15.30)
Refit	11.49 (5.65–20.12)	21.84 (13.69–31.98)	25.29 (16.58–35.75)
Ops/Harbour	18.75 (10.89–29.03)	31.25 (21.35–42.59)	27.50 (18.10–38.62)
Ops/Sea	76.04 (66.25–84.17)	100.00 (100.00–100.00)	100.00 (100.00–100.00)
P value [†]	0.000	0.000	0.000
P value [‡]	0.201	0.017	0.001
<i>Rank</i>			
Officer	50.00 (29.93–70.07)	73.08 (52.21–88.43)	19.23 (6.55–39.35)
Sailor	28.27 (23.59–33.47)	48.21 (42.78–53.69)	42.56 (37.24–48.05)
P value [†]	0.020	0.015	0.020
<i>Age groups</i>			
≤24	48.98 (34.42–63.66)	63.27 (48.29–76.58)	57.14 (42.21–71.18)
25–34	29.20 (23.36–35.60)	48.67 (41.99–55.39)	40.27 (33.82–46.97)
35–44	24.24 (14.54–36.36)	50.00 (37.43–62.57)	40.91 (28.95–53.71)
≥45	9.52 (1.17–30.38)	33.34 (14.59–56.97)	9.52 (1.17–30.38)
P value [†]	0.003	0.114	0.003

[†] Chi-square test: All four study groups.
[‡] Chi-square test: Non-Sea groups.

There was neither any statistical difference in work- and transport-related activity between the age groups (Table 1) nor was there in distribution of crew as per activity levels (Table 2) even though it was seen that the youngest age group (≤24 year olds) had least physical activity in all three domains as also the highest number of crew having Low physical activity level. The individuals in the youngest age group (≤24 year olds) also had the maximum number of crew doing no work-transport-or-recreational activity (Table 3).

No work-transport-or-recreational activity

Table 3 shows percentage of participants doing no work-transport-or-recreational activity distributed by study groups, rank and age groups. Overall, 29.83% individuals did not do any work-related physical activity, 50.00% did not do any transport-related activity and 40.88% did not perform any recreational physical activity. Within the study groups, significant differences were seen within the three Non-Sea groups in transport and recreational activity. The Base group was the most active in recreational activity and least active in transport-related physical activity. In this group, 41.41% of the crew did not do any transport-related (P value = 0.017) and only 8.08% crew did not do any recreational physical activity.

Discussion

Physical activity is a dynamic behavioural process rather than a static process, with the patterns changing constantly over the years.⁹ However for submariners, with unpredictable working schedules, the pattern of physical activity can change more frequently, regardless of whether the individual is posted on an operational submarine or in the base. Many times, it becomes extremely difficult for an individual to set a definitive routine in daily life; as a result of which, he is unable to set a physical activity routine for himself. A need was, therefore, felt to customise the physical activity profile of submarine crew. As a first step, this pilot study was carried out to identify and bring out the current physical activity profile of the submarine crew across the three physical activity domains.

Overall activity status and recreational physical activity

To promote and maintain health, all healthy adults aged 18–65 years need moderate-intensity aerobic (endurance) physical activity for a minimum of 30 min five days a week or vigorous-intensity aerobic physical activity for a minimum of 20 min three days a week. Combinations of moderate- and

vigorous-intensity activity can be performed to meet this recommendation.¹⁰ Applying this cut-off, the present study showed that 30.11% of the submarine crew are insufficiently active. WHO in 2008, had estimated 12.7% of the Indian males to be physically inactive³ compared to which, 30.11% of submarine crew being inactive is alarming. However, this 30.11% represents the entire study population and conclusions vary within the four study groups. Base and Refit groups had relatively healthy figures with only 4.04% and 5.75% crew in the physically inactive group. Ops/Harbour group had 15% physically inactive crew. Ops/Sea group was the most affected groups as 91.67% of the crew were physically inactive.

Most of the activity for Refit and Ops/Harbour groups originated from activity at work. About one-fourth of the crew (25.29% and 27.50% respectively) in these two groups did not do any recreational activity. The Base group fared better with 43.22% of the total activity being derived from recreational activity and only 8.08% crew doing no recreational activity.

Within the three Non-Sea groups (Base, Refit and Ops/Harbour groups), the pattern of physical activity observed could be due to the work requirement and working schedules of these groups. Individuals in the Base have more predictable working hours and schedule compared to other groups, thus enabling them to indulge in greater recreational physical activity. Crew onboard a Refit or an Operational submarine in harbour would be required to indulge in greater work related activity due to the manual labour involved in maintenance activities. This combined with unpredictable working schedule would make it difficult for the individual to indulge in recreational physical activity.

Several studies have suggested that leisure time physical activity is associated with a reduced risk of cardiovascular as well as all-cause mortality in men and women independent of their level of occupational physical activity.¹¹⁻¹⁴ Studies have even demonstrated a high risk of increased cardiovascular diseases and mortality in individuals with high work related activity because of the different characteristics of leisure and work-related activity.¹⁵ Higher work related activity and the lack of recreational physical activity in submarine crew, therefore, is a major cause for concern.

Crew in operational submarines

In any study conducted on submarine crew, the primary focus is on the submarine crew of operational submarines while at sea. Two factors affect physical activity inside the submarine: lack of space for exercise and limited atmosphere regeneration facilities which are unable to cater for increased carbon dioxide production during exercise. From the results of the present study, the almost total lack of physical activity was evident. Even for those who were active at sea, the entire activity was work-related and did not in any case contribute towards better health.

On the contrary, the same crew when in harbour did perform much greater physical activity. Choi et al.⁴ had also demonstrated the stark contrast between ambulatory activity at sea and when in harbour in South Korean submarine crew. However, what was additionally seen in the present study that most of the activity in harbour was work related activity and

the crew still did not indulge in ample recreational activity. Compared to the Base and the Refit groups, the Ops/Harbour group had the least amount of recreational activity in METs-Minutes-per-Week, maximum number of physically inactive crew, and the highest number of crew doing no-recreational activity.

This data demonstrates, therefore, that there is this group of submarine crew onboard an operational submarine who is not indulging in any physical activity while deployed at sea, but is also not engaging in any recreational physical activity during the time spent in harbour. While lack of physical activity when deployed at sea cannot be changed, the lack of recreational physical activity while in harbour definitely needs to be addressed. Working schedule, fatigue from work and pending family commitments could be reasons for this activity pattern.

Transport related activity

Socioeconomic changes have led to profound alterations in individual lifestyles, with motorised transport being increasingly used for commuting to and from work and for daily household chores. This was evident in the data collected as Transport related activity contributed the least towards physical activity across all study-groups as well as all age-groups. With most individuals in the present study living 5-6 km away from the work place, interventions promoting active transportation to work could have a marked effect in the overall physical activity state.^{16,17}

Other findings

Even though the total activity of officers and sailors was comparable, the domain-wise profile was contrasting. More than 50% of the sailors' activity was work-related and almost 80% activity of the officers was recreational. While lack of work related activity for officers is in consonance with the work culture lack of recreational activity for sailors is of concern. Whether it is due to fatigue at work or due to more unpredictable working culture or because of lesser awareness remains to be seen and addressed.

Previous studies have shown a trend for decreasing physical activity levels with increasing age.^{7,8} In the present study, the younger age groups had a worse physical activity profile compared to higher age groups. >45 year-olds had the highest mean physical activity, higher work-related activity than the <24 year-olds and performed almost three times greater recreational activity than the <24 year-olds. Though the reason for the disparity is simple (crew onboard operational submarines was younger than those in the base and therefore, physically inactive at sea), the repercussions are not. A recent study revealed that occupational stress in naval personnel can be mitigated by social support in officers and senior sailors but not in junior sailors.^{18,19} As it is, recreational physical activity itself helps mitigate stress, and thus an intervention targeted at increasing recreational physical activity in younger individuals would be beneficial both ways. Moreover, continued efforts would be required to modify the existing patterns before they become established specially in this younger age group.

Conclusion

With the rising burden of non-communicable diseases, concerns related to physical inactivity can no more be ignored. In the present study, the crew in the Base group had the best physical activity profile. Even though the crew in Refit submarines did not fare much better, the greatest cause for concern comes from the crew in operational submarines and the younger crew. Physical activity profile of the crew when at sea cannot be changed and operational concerns are always primary. However, what can be modified are the presently prevalent work schedules for refit submarines and operational submarines when in harbour.²⁰ Targeted interventions and strategies are required to establish sustainable behaviour patterns with regards to physical activity in these groups. Specific interventions also need to be targeted towards the younger crew. Command and control authorities need to resource, develop and implement strategies with a long-term perspective to enable crew to meet the desired recommendations.

The authors acknowledge that certain factors might influence the findings of the current study. Over-reporting due to recall bias or social desirability cannot be dismissed in self-reporting measures like the GPAQ and could have led to our overestimating physical activity.

Conflicts of interest

The authors have none to declare.

REFERENCES

1. WHO. *Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks*. Geneva: World Health Organization; 2009.
2. Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, Ekelund U. Global physical activity levels: surveillance progress, pitfalls, and prospects. *Lancet*. 2012;380:247–257.
3. WHO. *Global Health Observatory Data Repository*. 2011 Available from: <http://apps.who.int/ghodata/> [accessed January 2013].
4. Choi SW, Lee JH, Jang YK, Kim JR. Assessment of ambulatory activity in the Republic of Korea Navy submarine crew. *Undersea Hyperb Med*. 2010;37(6):413–417.
5. WHO. *Global Physical Activity Surveillance*. 2011 Available from: <http://www.who.int/chp/steps/GPAQ/en/index.html> [accessed January 13].
6. Bull FC, Maslin TS, Armstrong T. Global physical activity questionnaire (GPAQ): nine country reliability and validity study. *J Phys Act Health*. 2009;6(6):790–804.
7. Trinh OT, Nguyen ND, Dibley MJ, Phongsavan P, Bauman AE. The prevalence and correlates of physical inactivity among adults in Ho Chi Minh City. *BMC Public Health*. 2008;8:204–214.
8. Amin TT, Al Khoudair AS, Al Harbi MA, Al Ali AR. Leisure time physical activity in Saudi Arabia: prevalence, pattern and determining factors. *Asian Pac J Cancer Prev*. 2012;13:351–360.
9. Barnett TA, Gauvin L, Craig CL, Katzmarzyk PT. Distinct trajectories of leisure time physical activity and predictors of trajectory class membership: a 22 year cohort study. *Int J Behav Nutr Phys Act*. 2008;5:57.
10. WHO. *Global Recommendations on Physical Activity for Health*. Geneva: World Health Organization; 2010.
11. Holtermann A, Marott JL, Gyntelberg F, et al. Does the benefit on survival from leisure time physical activity depend on physical activity at work? A prospective cohort study. *PLOS ONE*. 2013;8(1):e54548.
12. Clays E, Bacquer DD, Herck KV, Becker GD, Kittel F, Holtermann A. Occupational and leisure time physical activity in contrasting relation to ambulatory blood pressure. *BMC Public Health*. 2012;12:1002–1010.
13. Holtermann A, Burr H, Hansen JV, Krause N, Søgaard K, Mortensen OS. Occupational physical activity and mortality among Danish workers. *Int Arch Occup Environ Health*. 2012;85:305–310.
14. Holtermann A, Marott JL, Gyntelberg F, et al. Occupational and leisure time physical activity: risk of all-cause mortality and myocardial infarction in the Copenhagen City Heart Study. A prospective cohort study. *BMJ Open*. 2012;13:2.
15. Holtermann A, Hansen JV, Burr H, Søgaard K, Sjøgaard G. The health paradox of occupational and leisure-time physical activity. *Br J Sports Med*. 2012;46:291–295.
16. Ogilvie D, Foster CE, Rothnie H, et al. Interventions to promote walking: systematic review. *BMJ*. 2007;334:1204.
17. Pucher J, Buehler R, Bassett DR, Dannenberg AL. Walking and cycling to health: a comparative analysis of city, state and international data. *Am J Public Health*. 2010;100:1986–1992.
18. Pawar AA, Chikkanna CB, Rote MS, et al. Occupational stress and social support in naval personnel. *Med J Armed Forces India*. 2012;68(4):360–365.
19. DGAFMS. *Report on the Health of the Armed Forces*. 2005 [Para 1.32 & 1.35].
20. Nasser A. Physical activity of submariners: an analysis. In: *Proceedings of the XXVIII Annual Conference of the Marine Medical Society*, 20–21 October 2012, Mumbai. Mumbai: Marine Medical Society; 2012:38.