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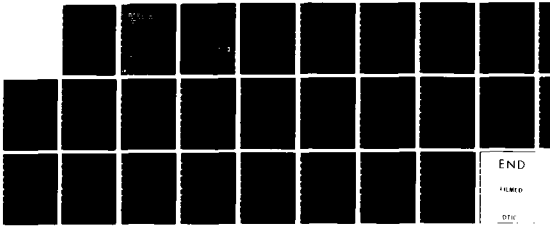

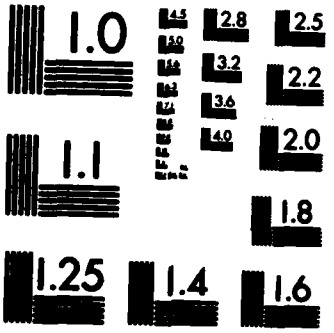

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NONCOMPLIANCE WITH COLD WEATHER MEDICAL GUIDELINES: ESTIMATES OF FREQUENCY AND IMPACT ON WELL-BEING IN MARINE CORPS COLD WEATHER TRAINING

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NONCOMPLIANCE WITH COLD WEATHER MEDICAL GUIDELINES:

Estimates of Frequency and Impact on Well-Being in Marine Corps Cold Weather Training†

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SUMMARY

Illness produces significant manpower losses during cold weather military operations. There is indirect evidence that noncompliance with cold weather medical guidelines contributes to these losses, but this possibility has not been systematically studied. The present study was designed to estimate the frequency of noncompliance in the cold and to provide initial assessments of the impact of noncompliance on well-being.

Men (n=161) from 3 Marine Corps rifle companies completed questionnaires describing liquid consumption, eating habits, and hygiene (with an emphasis on foot care) during cold weather training field exercises which lasted 3 to 4 days. Physical well-being was measured by self-reported physical symptoms.

The estimated noncompliance rate for liquid consumption was 11% based on a 2 quarts/day guideline and 73% based on a 4 quarts/day guideline. An estimated 22% of the men consumed less than 3000 calories per day compared to a guideline of 3200. Foot care noncompliance was 16% if the criterion was performing at least one foot care activity on a daily basis and 41% if the criterion was changing socks and drying the feet daily.

Noncompliance had limited effects on well-being. Liquid consumption and foot care were essentially independent of well-being, but men who regularly ate the main course, confections, and spreads in the Meals, Ready-to-Eat (MREs) reported 29% fewer symptoms than those who ate these MRE portions sporadically.

Noncompliance occurred frequently enough to be a potentially important source of illness in cold weather operations. The limited impact of noncompliance on well-being probably reflects the relatively mild weather conditions and brief periods of exposure to the cold that the men encountered during the study. Similar behavior would be expected to produce health problems given more extreme conditions. These findings suggest that further research would be worthwhile to detail the specific conditions under which noncompliance with health maintenance guidelines actually produces illness and the methods to improve behavioral patterns where appropriate.

Contents

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INTRODUCTION

Illness historically has produced significant manpower losses during cold weather military operations. These losses have been substantial even when only cold injuries were considered (1,2). Studies of cold weather training have shown that cold injuries represent only a small proportion of the illness occurring during cold weather operations (3-7). Although most cold weather illnesses are minor (e.g., upper respiratory infections), even minor illnesses can markedly reduce effectiveness in the cold (8). Because the effects of cold on health can be substantial, finding ways to maintain well-being should significantly improve operational effectiveness in cold weather.

One possible way to reduce the impact of cold weather on well-being is to increase the frequency of health maintenance behaviors. According to field manuals, key behaviors affecting health in the cold include liquid consumption, dietary habits, and certain aspects of personal hygiene, most notably proper foot care (9,10). When actual behavior falls short of the guidelines provided for troops in the cold, the individual is noncompliant just as he would be if he failed to follow any other medical regimen. Indirect evidence suggests that noncompliance with guidelines significantly affects well-being in the cold:

(a) Field observations suggest that men can become unmotivated and uncaring in the cold and that this leads to reduced attention to nutrition and hygiene with a resulting increase in the likelihood of illness (4).

(b) Cold injuries occur even though they are preventable if health maintenance guidelines are followed (9-11).

(c) A negativistic personality is believed to be associated with higher probability of cold injury (12). Similar personality attributes have been associated with poor compliance with other medical regimens in clinical settings (13).

(d) One health maintenance guideline is that men should maintain adequate liquid consumption. Observations of cold weather training consistently suggest that actual consumption is below recommended levels (4,14,15).

This research was undertaken because health maintenance behaviors in the cold have not been systematically studied. The objective of this study was to describe health-related behaviors during cold weather training. Comparing the observed behaviors to medical guidelines provides a basis for evaluating whether noncompliance occurs often enough to be a potentially important contributor to illness in the cold. Evidence regarding the impact of noncompliance in the specific training setting studied is provided by relating behavior to self-reported physical well-being.

METHOD

Sample. Marine Corps volunteers (n = 190) from 3 rifle companies participated in the study after giving informed consent. Subsequently, 161 men completed the Field Behavior Questionnaire (FBQ) which provided the data for this report. Of the remaining 29 men, 26 could not return for their testing session because a change in plans required them to leave prior to the scheduled data collection. Thus, the dropout rate after the consent session was 2.1%. The demographic characteristics of the resulting sample are shown in Table 1.

TABLE 1
DEMOGRAPHIC CHARACTERISTICS OF STUDY PARTICIPANTS

CHARACTERISTIC	CATEGORY	PERCENT OF SAMPLE
AGE (in years)	18	5.2%
	19	29.4%
	20	22.2%
	21	15.7%
	22	11.1%
	23 or more	16.5%
RACE	White	65.8%
	Black	19.5%
	Hispanic	9.6%
	Other	4.9%
SCHOOLING	Less than 12 years	15.8%
	12 years	79.6%
	More than 12 years	4.6%
RANK	E-1	5.9%
	E-2	16.3%
	E-3	57.5%
	E-4	15.7%
	E-5/E-6	4.6%
LENGTH OF SERVICE	Less than 1 year	10.0%
	1 - 2 years	26.0%
	2 - 3 years	38.8%
	3 - 4 years	15.3%
	4 or more years	10.0%

NOTE: Percentages were based on responses of individuals completing the question. Missing data ranged from 8 (5.0% of total sample) to 15 (9.3% of total sample). Tabled percentages may not sum to 100% in all cases due to rounding.

Study Setting and Research Design. The study took place during cold weather training at the Marine Corps Mountain Warfare Training Center (MWTC), Bridgeport, CA. The MWTC facilities are approximately 6500 feet above sea level with training activities carried out up to altitudes of approximately 8000 feet. Precise meteorological data were not available for the period of study, but the temperature was generally above freezing during the daylight hours with occasional wind and snow squalls.

The general structure of the training program consisted of two phases. Phase I, which lasted 10 days, taught basic cold weather survival skills. Phase II applied the skills and knowledge acquired in Phase I to tactical maneuvers. Four field training exercises during Phase II provided experience in planning and executing tactical maneuvers in the cold. Each field training exercise lasted 3 to 4 days with a 16- to 44-hour rest and recovery period between exercises.

Data were collected during Phase II at the end of the first, second, and fourth field training exercises. Three platoons were sampled from two of the three rifle companies studied. In each of these companies, a different platoon provided data after each exercise. Two platoons from the third rifle company provided data, one after the first field exercise and the other after the second exercise. The third company departed almost immediately after the last field exercise, so the planned data collection for a third platoon in this company could not be completed.

Health Maintenance Behaviors. A Field Behavior Questionnaire (FBQ) was developed to obtain reports of the frequency of health maintenance behaviors (see Appendix A). The FBQ asked participants to describe: (a) their liquid consumption, (b) the frequency of consuming each of the major components of the "Meals, Ready to Eat" (hereafter, MREs) which were the field rations, and (c) the frequency of a series of hygiene behaviors with an emphasis on foot care. These behaviors were studied because field manuals describe them as a means of ensuring good health in the cold (9,10). The FBQ also contained several additional questions about taking one's own food to the field, snacking between meals, and taking vitamins.

Assessment of Physical Well-being. Physical well-being was measured by self-reports of physical symptoms. Symptom reports were chosen to estimate health status for three reasons. First, prior research (4) indicated that a substantial proportion of cold weather training illness is never recorded in clinical records.

Second, symptom reports are sensitive to mild illness (16). Because the training program called for short periods in the field, noncompliance was expected to produce only mild health problems. Third, symptoms such as dizziness, nausea, blurred vision, etc., imply temporary performance impairment even if the person does not become clinically ill. In terms of operational effectiveness, such symptoms are important even when they only represent reactions to environmental factors (e.g., temperature, humidity, altitude) or acute work load demands.

A 36-item symptom checklist covered a wide range of symptoms which were likely to occur in the cold (see Appendix A). A two-step procedure reduced this list to six symptom clusters approximating clinical descriptions of cold weather health problems as closely as possible while avoiding item overlap between clusters:

(a) Symptoms were grouped based on sets defined in the field manuals (9,10) as indicators of a cold weather health problem (e.g., dehydration) or on definitions of illnesses that are common in cold weather training (e.g., upper respiratory infection).

(b) Substantial item overlap was observed in the clusters resulting from (a). For example, the symptom "dizziness" was originally listed as an element in two clusters. Therefore the correlations between items originally assigned to more than one cluster and other items in those clusters were examined. The symptom was then assigned to the cluster for which the average interitem correlation with other items in the cluster was highest. This step minimized redundancy between clusters.

The result was 6 symptom clusters labelled "Chill", "Eye Problems", "Nonspecific Cold Weather Symptoms" (referred to as "Nonspecific"), "Gastrointestinal/Viral Syndrome" (referred to as "GI/Viral"), "Upper Respiratory Infection" (referred to as "URI"), and "Miscellaneous" (see Appendix B). The "Nonspecific" cluster included symptoms which were listed in cold weather manuals as indicators of several cold weather illnesses (e.g., dehydration, hypothermia, etc.). This category was constructed to approximate the occurrence of cold-induced health problems; illness-specific symptom clusters could not be formed because the symptoms for many cold-induced health problems are similar. The "Miscellaneous" cluster included symptoms which represented a variety of health problems, none of which were expected to produce more than 1 or 2 of the 10 symptoms in the cluster. This cluster did not approximate any common clinical diagnosis, but was included so that each symptom was represented in one of the 6 clusters.

The data showed a high frequency of symptom reports as expected (see Appendix B). Thus, the measures were sufficiently sensitive to the mild illnesses occurring during training to provide appropriate criterion variables for evaluating the effects of health behaviors.

Analysis Procedures. Frequency distributions for health behaviors and symptoms were obtained. The distributions for health maintenance behaviors described behavioral patterns in the cold, thereby providing the basis for comparing actual behavior to health maintenance guidelines. Estimates of the frequency of noncompliance were derived by determining what proportion of the men fell below the behavioral level recommended by health guidelines.

To determine how strongly physical well-being was related to health maintenance behaviors, respondents were divided into groups based on reported frequency of each behavior (see Appendix C). Wherever possible, 3 groups were formed to represent low, medium, and high frequency relative to the sample norms. When nearly all study participants reported the same level of behavior, only low and high frequency groups could be formed. The recoded scores were employed to compare the frequency of symptoms in the low and high frequency groups to estimate how much differences in behavior affected the probability of experiencing symptoms of ill health during cold weather training.

The Kendall-Stuart tau_c was used as an overall measure of association between the recoded health maintenance behaviors and health symptoms (17). When the tau_c was significant, relative risk for symptoms was computed. Relative risk was defined as the increase in symptom probability for the low group relative to the high group. Relative risk for symptom clusters was computed with the probability for a single symptom replaced by the average probability for the symptoms in the cluster. Relative risk could differ from tau_c because these estimates depend only on the two extreme groups while tau_c involved three groups.

Health Maintenance Behaviors and Compliance in the Field

Liquid Consumption. The average reported liquid consumption was 2.90 quarts per day with most men drinking between 2 and 4 quarts per day (see Figure 1).

Defining the noncompliance rate as the percentage of men drinking less than the recommended daily water intake, several noncompliance rates were computed based on liquid consumption recommendations available from different sources:

(a) 72.5% based on a 4.0 quarts/day guideline (lower limit of training program recommendations).

(b) 70.7% based on a 3.6 quarts/day guideline (developed in recent research, 18).

(c) 10.6% based on a 2.0 quarts/day guideline (minimum estimate from Navy medical manual, 19).

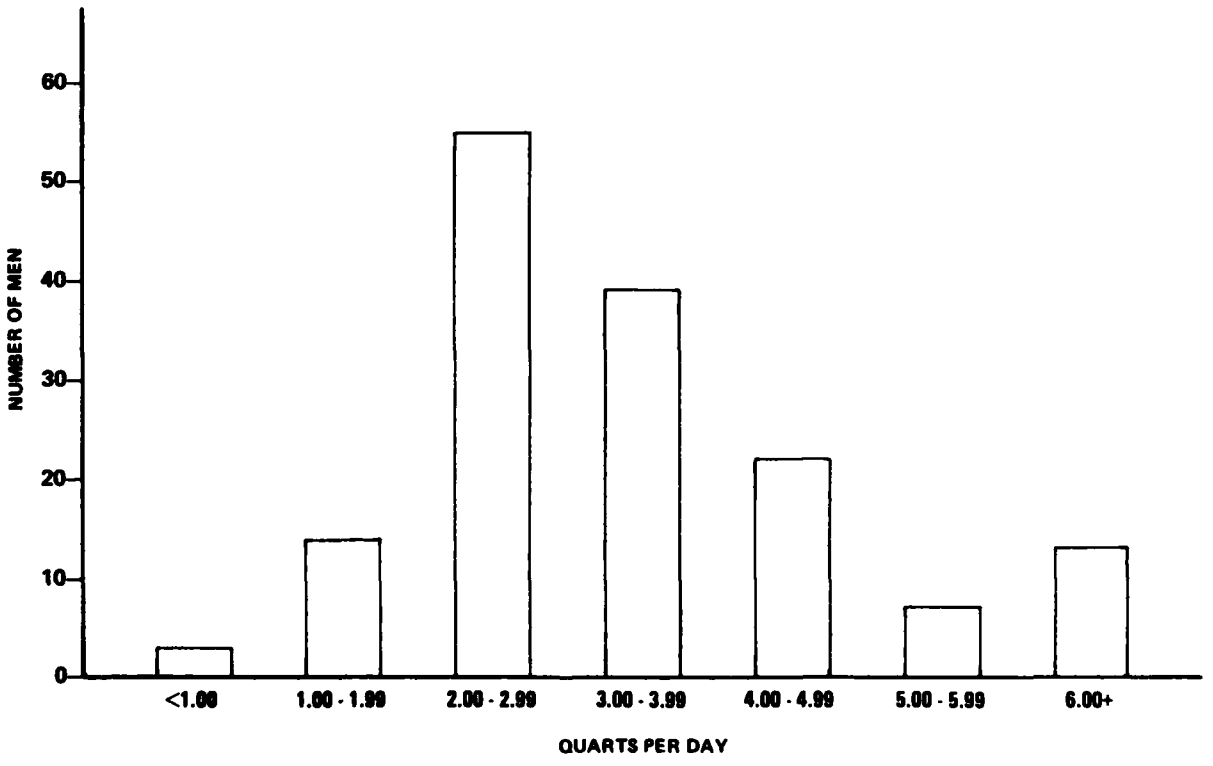

Figure 1. Reported daily water consumption.

Eating Habits. Major findings were:

(a) The main course of the meal was consumed regularly by most men, but other portions were eaten more sporadically (see Table 2).

(b) Salt and coffee were infrequently used.

Most men (62%) did not use the extra salt in the meal packets; another 21% of the men used extra salt less than once a day. Even fewer men used the coffee (83% less than once per field training exercise). Both points may be important for defining liquid consumption standards for this population.

TABLE 2
REPORTED EATING HABITS

		NEVER	ONCE/ EXERCISE[a]	EVERY OTHER DAY	ONCE PER DAY	TWICE PER DAY	THREE TIMES PER DAY
MAIN COURSE	n =[b]	1	2	5	16	26	111[c]
	%	0.6	1.3	3.1	9.9	16.2	68.9
CRACKERS	n =	12	26	26	18	28	50[d]
	%	7.5	16.2	16.3	11.2	17.6	31.2
SPREADS[e]	n =	5	13	34	22	29	59
	%	3.1	8.0	21.0	13.6	17.9	36.4
CONFECTIONS[f]	n =	6	11	17	37	28	61
	%	3.8	6.9	10.6	23.1	17.5	38.1
COFFEE	n =	115	13	12	8	5	2
	%	74.2	8.4	7.7	5.2	3.2	1.3
COCOA	n =	17	19	37	45	20	21
	%	10.7	11.9	23.3	28.3	12.6	13.2
EXTRA SALT	n =	95	24	9	11	5	10
	%	61.7	15.6	5.8	7.1	3.2	6.5
SUGAR	n =	67	21	23	22	13	10
	%	42.9	13.5	14.8	14.1	8.3	6.4
FRUIT	n =	30	22	26	30	21	25
	%	19.5	14.3	16.8	19.5	13.7	16.2
VITAMINS	n =	144	6	3	8	0	0
	%	89.4	3.8	1.8	5.0	0.0	0.0

NOTE: The number of men included for each behavior varies from 154 to 161 because of missing data.

[a] Each field exercise lasted 3 to 4 days.

[b] "n =" indicates the number of men giving this response. "%" translates this number into a percentage based on the number of men responding to the item.

[c] Includes 2 men who indicated eating more than 3 per day.

[d] Includes 1 man who indicated eating more than 3 per day.

[e] Includes cheese, peanut butter, and jelly spreads for crackers.

[f] Includes chocolate, caramels, and nutcakes.

An estimate of the noncompliance rate for nutrition was developed based on the consumption of the confections. The confections provide an average of 356 of the 1208 calories in the MREs. If no other food sources were available, a man who reported eating these confections once a day or less would be noncompliant because he would average fewer than 3000 calories which is below the minimum recommended intake of 3200 calories per day for cold weather operations (20,21). Applying this criterion, 44.5% of the men were noncompliant; however, half of these men took personally purchased food stuffs to the field. Assuming that the personal purchases completely offset the calories lost by omitting parts of the MRE would leave 22.3% of the men noncompliant. This noncompliance estimate is a conservative lower limit because it is based on a single MRE component and because the assumption that personally purchased foodstuffs completely offset the calories lost by omitting MRE components is probably too lenient.

Personal Hygiene in the Field. Although most foot care activities were performed at least daily by a majority of the men (see Table 3), more detailed examination of hygiene behaviors showed that:

(a) 16% of the men did not perform even one footcare activity on a daily basis.

(b) Another 25% of the men either changed their socks daily or dried their feet daily, but did not do both daily.

If daily performance of these two behaviors were the criterion for compliance, a total of 41% of the men studied would be classified as noncompliant.

(c) 46% of the men engaged in three or more foot care activities on a daily basis.

A substantial minority of the men (37%) used foot powder daily in addition to changing their socks and drying their feet. A much smaller number of men (9%) reported those three activities plus washing their feet at least once a day.

Overall Noncompliance. The total number of men at risk because of noncompliance will substantially exceed the estimate for any single behavior, because the men who drink too little frequently were not ones who ate too little, etc. (see Appendix C). Defining noncompliance as (a) less than 2 quarts of water per day, (b) no daily foot care activities, and (c) confections eaten once a day or less with no personal food taken to the field, 33.5% of the men were noncompliant for at least one behavior.

TABLE 3

FOOTCARE AND OTHER HYGIENE BEHAVIORS

		NEVER	ONCE/ EXERCISE[a]	EVERY OTHER DAY	ONCE PER DAY	TWICE PER DAY	THREE TIMES PER DAY
CHANGE SOCKS	n =[b]	3	25	35	91	8	0
	%	1.9	15.4	21.6	56.2	4.9	0.0
WASH FEET	n =	93	29	17	19	1	0
	%	58.5	18.2	10.8	12.0	0.6	0.0
DRY FEET	n =	8	15	13	108	15	2
	%	5.0	9.3	8.1	67.0	14.4	1.2
FOOT POWDER	n =	28	23	25	73	11	2
	%	17.3	14.2	15.4	45.1	6.8	1.2
FEET CHECKED BY CORPSMAN	n =	138	18	4	0	0	0
	%	86.2	11.3	2.5	0.0	0.0	0.0
OTHER HYGIENE ACTIVITIES							
SHAVE	n =	81	46	26	8	0	0
	%	50.3	28.6	16.1	5.0	0.0	0.0
CHANGE UNDERWEAR	n =	51	44	35	18	0	0
	%	34.5	29.7	23.6	12.2	0.0	0.0
BRUSH TEETH	n =	35	30	29	53	12	0
	%	22.0	18.7	18.2	33.4	7.5	0.0

[a] Each field exercise lasted 3 to 4 days.

[b] "n =" indicates the number of men giving this response. "%" translates this number into a percentage based on the number of men responding to the item.

Health Maintenance Behaviors and Physical Well-being

Liquid Consumption and Physical Well-being. Adequate liquid consumption should reduce the incidence of dehydration symptoms. Minor effects on other symptoms could occur if dehydration contributes to other health problems.

(a) Liquid consumption was not significantly related to any symptom cluster, but was significantly related to two symptoms which might accompany dehydration.

Significant associations were found between liquid consumption and the dehydration symptoms of dizziness ($tau = -.25$, $p < .002$) and stomach cramps ($tau = -.15$, $p < .032$). Other significant associations were: diarrhea, ($tau = -.10$, $p < .006$); swollen feet ($tau = -.09$, $p < .022$).

(b) The associations for the dehydration symptoms implied substanial differences in symptom frequency for compliant and noncompliant individuals.

Although the absolute magnitude of the associations was small, the odds that a noncompliant individual would experience each symptom were 2.4 to 1 for dizziness and 2.9 to 1 for stomach cramps.

Eating Habits and Well-being. Nutrition-health associations were determined separately for each major MRE component:

(a) Eating the main course, spreads, and confections contributed to well-being.

Seventeen of 21 (81.0%) correlations between the symptom clusters and consumption patterns for these 3 MRE components were significant (see Table 4). On the average, the marines in the high frequency groups for these behaviors had 29% fewer symptoms than those in the low frequency groups.

(b) Consumption of crackers, cocoa, and fruit had less general effects on well-being.

Only 3 of 21 (14.3%) correlations to the symptom clusters were significant. On the average, the marines in the high frequency groups for these behaviors had 13% fewer symptoms than those in the low frequency groups.

(c) Consumption of coffee, salt, and sugar was not related to physical well-being.

TABLE 4
ASSOCIATIONS BETWEEN NUTRITIONAL HABITS AND SYMPTOM REPORTS

	TOTAL			CHILL		EYES		NONSPECIFIC		GI/VIRAL		URI		MISC.	
	tau[a]	#[b]	Neg[c]	tau	#	tau	#	tau	#	tau	#	tau	#	tau	#
MAIN COURSE	−.20**	11	30	−.13*	2	−.16**	1	−.16**	3	−.18**	1	.00	0	−.15*	4
CRACKERS	−.15*	5	26	−.10	1	−.09	1	−.08	1	−.10	1	.02	0	−.19**	1
SPREADS	−.23**	13	34	−.14*	1	−.15*	1	−.16*	4	−.17**	2	−.03	0	−.25**	5
CONFECTIONS	−.20**	11	29	−.21**	3	−.17**	3	−.19**	3	−.09	0	.08	0	−.21**	2
COCOA	−.12	4	30	−.14*	2	−.08	0	−.07	0	−.09	0	−.05	0	−.06	2
COFFEE	−.06	2	27	−.05	0	−.03	0	−.06	2	−.01	0	.06	0	−.11*	0
FRUIT	−.10	6	24	−.03	1	−.10	1	−.05	1	−.06	1	.05	0	−.10	2
VITAMINS	.05	5	13	.02	0	−.06	0	.03	4	.15**	1	.02	0	.04	0
SUGAR	.07	4	12	.07	1	.04	0	.07	1	.01	0	.08	0	.06	2
EXTRA SALT	.05	6	12	−.05	0	.03	1	.06	1	.07	2	.01	0	.07	2
TOTAL		*67*	*237*		*11*		*7*		*20*		*8*		*0*		*20*
Possible		*360*	*360*		*50*		*40*		*90*		*70*		*20*		*100*
Percentage		*19*	*66*		*22*		*18*		*22*		*11*		*0*		*20*

[a] tau = Goodman and Kruskal's tau_c (17).

[b] # = the number of significant correlations to individual symptoms.

[c] Neg = the number of negative correlations. Indicated because a negative correlation is consistent with the hypothesis that poorer nutrition is associated with a greater likelihood of illness.

* $p < .05$
** $p < .01$

(d) Taking vitamins was associated with an above average likelihood of "GI/Viral" symptoms.

Significant associations were observed for the "GI/Viral" syndrome cluster (tau = .19, $p < .004$) and for 5 individual symptoms: upset stomach (tau = .13, $p < .001$), congested nose (tau = .09, $p < .015$), diarrhea (tau = .08, $p < .001$), and chills (tau = .09, $p < .24$), and stomach cramps (tau = .08, $p < .028$).[1]

(e) "URI" was not related to nutritional behaviors.

Hygiene and Physical Well-being. Hygiene behaviors were expected to have little, if any, association to well-being other than associations to foot problems and/or chilling. Findings were:

(a) Non-foot care hygiene behaviors were virtually independent of health status.

(b) Foot care was weakly related to symptoms of trenchfoot or chilling/frostnip of the feet.

Foot care predicted the "Chill" cluster (tau = -.11, $p < .05$) which included the two symptoms reflecting cold feet. However, neither of the individual symptoms of cold feet was significantly related to foot care.

DISCUSSION

Noncompliance with cold weather medical guidelines occurred often enough to be a potentially important cause of health problems in the cold. Eleven to 73% of the study participants were noncompliant depending on the specific health behavior considered and the exact criterion used to define noncompliance. Applying the most conservative criteria for each of the three behaviors studied, noncompliance with at least one health maintenance guideline increased the risk of illness for one-third of the men.

One issue in the interpretation of these findings is whether they are representative of typical cold weather behavior. Our finding of an average liquid consumption rate of 2.90 quarts per day was higher than the 2.34 quarts per day reported in other cold weather research (14). The higher value in this study may have been the result of asking for the "average per day" over a several day period. Observations during our data collection suggested that some men may have reported total consumption during the field exercise. This confusion may have

[1]A two-tailed significance level would be appropriate because we did not predict the observed direction of the associations. The one-tailed indication was retained to be consistent with the presentation of other findings. Changing to a two-tailed test would affect only the conclusion for stomach cramps.

arisen because the questionnaire asked for water consumed "during the previous exercise." The clarification of "average per day" was added because the length of the exercises varied slightly. This clarification was given verbally at each testing session, but some participants may have ignored the verbal instruction or failed to understand it. The possible confusion seems particularly applicable to those men reporting more than 6 quarts consumed per day (see Figure 1, p. 6). With these individuals excluded from the computations, the average liquid consumption was 2.66 quarts per day. Within the limitations of the data, this figure is quite comparable to the previous report of 2.34 quarts per day. Furthermore, the comparison suggests that our estimates of noncompliance err in the direction of underestimation if they err at all.

Similar comparisons were not possible for the other health behaviors because no comparable studies have been undertaken, so it is important to replicate the initial findings. In the absence of contradictory data, the tentative assumption that the present eating habit and foot care findings are also representative of typical cold weather behavior is reasonable.

Our findings with regard to the impact of noncompliance on well-being in the cold must be interpreted in context of the prevailing weather conditions and operational requirements. The weather was, in general, not extremely cold, and the men were in the field only for brief periods of time. The short stays in the field made it unlikely that foot care would be a source of health problems because a week or more in the field is about the minimum time period before noncompliance with foot care guidelines produces major problems (2). In the case of liquid consumption, the data suggested marginal dehydration in some men because two dehydration symptoms were significantly related to liquid consumption. With longer periods in the field and/or heavier work load, the observed pattern of behavior could lead to significant dehydration problems. There is adequate evidence from other sources that the observed foot care and liquid consumption behavior patterns would increase illness risk under conditions which might be anticipated in operational settings. Given these considerations plus the previously noted fact that inadequacy of foot care and liquid consumption should each affect only a few symptoms, the observed frequency of noncompliance for these behaviors probably should be regarded as more important than their limited impact on well-being in this particular study.

The qualifications for the liquid consumption and foot care findings are reminders that general medical guidelines necessarily simplify our knowledge regarding the linkages between behavior and well-being in the cold. For example, liquid and other nutritional requirements will vary with the amount of physical exertion, the size of the individual, and other factors. Therefore, one plausible interpretation of the present findings is that the men effectively adapted their drinking behavior to situational requirements so that liquid consumption contributed only slightly to poor health even though guidelines were not followed. Future work will consider more complex models incorporating situational factors and individual differences which may influence requirements to define the precise effects of noncompliance on well-being in the cold. An important issue in that research will be determining whether behaviors are modified to adapt to situational demands (e.g., weather, work load).

Despite the presence of conditions which may have minimized the effects of noncompliance, poor eating habits were associated with increased symptom frequency. Clearly, this aspect of health behavior was not being adapted to situational requirements. A tentative interpretation is that the observed associations represent transient effects of inadequate energy intake (e.g., symptoms of hypoglycemia) or some other short-term, reversible nutritional imbalance. This interpretation is more plausible than suggesting that poor eating habits produced clinically-defined illness during cold weather training because healthy young men should tolerate short periods of mild nutritional deprivation without substantial problems (22). The absence of an association between eating habits and URI symptoms suggests that the association to gastrointestinal symptoms did not reflect increased susceptibility to viral infections brought about by a general decrement in immunocompetence.

Because even transient physical symptoms imply a possible decrease in performance effectiveness, the proposed interpretation points to altering eating habits as a potential method to enhance cold weather effectiveness. This suggestion assumes that nutritional intake determines symptoms, but the reverse might also be true. If the present findings replicate in further research, the direction of causality should be a topic for future investigation. If at least part of the association proves to be attributable to an effect of nutrition on well-being, other issues for future consideration would include identifying specific nutritional components that are particularly important to well-being in the cold and

developing methods of producing appropriate nutritional intake (e.g., design of specific cold weather rations).

One surprising nutritional finding was that taking vitamins was associated with a higher probability of "GI/Viral" symptoms. This observation could be explained in several ways (e.g., experiencing the symptoms led some men to take vitamins or people who take vitamins are very health conscious and therefore more likely to be aware of and to report symptoms). However, because the finding was unexpected, it should be replicated before extensive efforts are directed toward explaining its occurrence.

In conclusion, the major finding of this study was that noncompliance with health maintenance guidelines occurred often enough to represent a potentially significant source of health problems in the cold. Although only eating habits were substantially related to well-being in this study, each of the three health maintenance behaviors studied deserves further investigation to define the conditions under which noncompliance impairs readiness and the overall impact of noncompliance on readiness.

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Appendix A

QUESTIONNAIRES ASSESSING FIELD BEHAVIORS AND SELF-REPORTED PHYSICAL SYMPTOMS

FIELD BEHAVIORS

1. **MARK THE POINT ON THE LINE BELOW THAT BEST INDICATES HOW MUCH LIQUID YOU CONSUMED ON THE AVERAGE DURING THE LAST EXERCISE. THE ESTIMATE SHOULD INCLUDE ALL WATER CONSUMED AND ANY ADDITIONAL LIQUIDS SUCH AS MILK OR JUICES THAT MAY HAVE BEEN SERVED WITH HOT MEALS. A CARTON OF MILK IS APPROXIMATELY 1/4 OF A CANTEEN AND A FULL CANTEEN CUP OF JUICE WOULD BE APPROXIMATELY 1/2 OF A CANTEEN.**

0 1 2 3 4 5 6 7 8

Number of Canteens

(If more than 8, write the estimated number here _____)

2. **INDICATE BELOW HOW OFTEN YOU ATE EACH OF THE INDICATED ITEMS IN YOUR MRE DURING YOUR LAST EXERCISE:**

	NEVER	ONCE	EVERY OTHER DAY	DAILY	TWICE A DAY	THREE TIMES A DAY
Main course	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Crackers	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Jelly/Cheese/Peanut Butter	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Cookies/candy	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Coffee	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Cocoa	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Extra Salt	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Sugar	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

3. **WAS THERE ANYTHING IN THE MREs THAT YOU DID NOT LIKE AND THEREFORE DID NOT EAT?**

_____

_____

_____

4. **CHECK THOSE THINGS THAT YOU DID DURING THE LAST EXERCISE:**

_____ Ate snacks in addition to main meals

_____ Took extra food to the field

_____ Took candy and cookies to the field

5. **INDICATE HOW OFTEN YOU DID EACH OF THE FOLLOWING FOR FOOT CARE AND HYGIENE. CHECK THE APPROPRIATE BOX.**

	NEVER	ONCE	EVERY OTHER DAY	DAILY	TWICE A DAY	THREE TIMES A DAY
Changed socks	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Washed feet	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Dryed feet	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Used foot powder	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Had feet checked by Corpsman	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Shaved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Changed underwear	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Brushed teeth	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Took vitamins	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Took a "snow bath"	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

PHYSICAL SYMPTOMS CHECKLIST

PLEASE CHECK THOSE SYMPTOMS THAT WERE PROBLEMS FOR YOU FOR 1 OR MORE DAYS DURING THE LAST EXERCISE.

_____ 1. Irritated or gritty feeling eyes.

_____ 2. Stomach cramps.

_____ 3. Muscle cramps other than stomach cramps.

_____ 4. Headaches.

_____ 5. Earache.

_____ 6. Dizziness.

_____ 7. General tiredness.

_____ 8. Aching joints or bones.

_____ 9. Nausea/vomiting.

_____10. Extremely dry mouth/throat.

_____11. Difficulty focusing eyes.

_____12. Cold/stiff hands.

_____13. Cold/stiff feet.

_____14. Swollen feet.

_____15. Blurred vision.

_____16. Hot, sticky feeling in eyes.

_____17. Tingling, aching feeling of hands after getting cold.

_____18. Tingling, aching feeling of feet after getting cold.

_____19. Cuts, scrapes, or abrasions.

_____20. Sprain or strain of legs, ankles, or feet.

_____21. Sprain or strain in upper body.

_____22. Sore throat.

_____23. Upset stomach.

_____24. Congested, stopped up nose.

_____25. Laryngitis.

_____26. Allergies.

_____27. Diarrhea.

_____28. Sleep problems.

_____29. Problems thinking clearly.

_____30. Nonproductive cough (no phlegm or mucous).

_____31. Productive cough (with phlegm or mucous).

_____32. Shortness of breath.

_____33. Fever.

_____34. Chills.

_____35. Skin rash.

_____36. Constipation.

Appendix B

INDIVIDUAL HEALTH SYMPTOMS AND HEALTH SYMPTOM CLUSTERS

INDIVIDUAL HEALTH SYMPTOMS AND HEALTH SYMPTOM CLUSTERS

Symptom Frequencies

The individual symptoms are listed in Table 1 from most frequently reported to least frequently reported.

Symptom Clusters

The symptom clusters used for our analyses were based on a combination of clinical descriptions of cold weather health problems and empirical considerations as described in the Method section (pp. 3-5). The resulting clusters were:

Chill: Cold hands, tingling hands, cold feet, tingling feet, swollen feet.

Eyes: Gritty, irritated eyes, sticky eyes, blurred vision, trouble focusing eyes.

Dehydration: Dizziness, dry mouth, muscle cramps, tired, aching joints/bones, headache, problems thinking, constipation.

Gastrointestinal/Viral Syndrome: Stomach cramps, nausea/vomiting, upset stomach, diarrhea, sore throat, fever, chills.

URI: Congested nose, productive cough.

Miscellaneous: Nonproductive cough, sprain of upper body, sprain of lower body, cuts/abrasions, earache, laryngitis, allergy, skin rash, sleep problems.

Descriptions of Physical Well-Being Based on Symptom Clusters

The subjective physical well-being of the marines, as reflected in scores for the symptom clusters, is described in Table B-2. The primary findings with regard to physical well-being were:

(a) The average study participant reported 12.5 symptoms, 34.7% of the total possible.

(b) Many of the common symptoms could be simple reactions to the physical environment and work requirements.

The 10 most common symptoms included cold hands (81%), tiredness (75%), tingling in hands when rewarmed (70%), aching joints/bones (67%), shortness of breath (65%), dry mouth (60%), and muscle cramps (48%). These symptoms could be reactions to the altitude, temperature, humidity, and work requirements of training.

(c) Symptoms related to upper respiratory infections were common.

Congested nose (80%), productive cough (57%) , and sore throat (57%) were among the 10 most frequent symptoms. The first two symptoms comprise the "URI" cluster and the last symptom could be a sign of "URI" in many cases even though it was assigned to the "GI/Viral" cluster.

(d) Injuries were common.

Cuts and/or abrasions (44%), sprain or strain of the upper body (34%), and sprain or strain of the lower body (30%) were frequently reported, but none of these were among the 10 most frequent symptoms.

(e) Scores for the symptom clusters were moderately positively correlated (see Table B-2).

TABLE B-1
FREQUENCY OF SPECIFIC HEALTH SYMPTOMS

SYMPTOM COMPLAINT	PERCENT REPORTING
COLD HANDS	80.8%
CONGESTED NOSE	80.1%
TIREDNESS	75.2%
TINGLING HANDS WHEN REWARMED	70.2%
ACHING JOINTS/BONES	66.5%
SHORTNESS OF BREATH	64.6%
DRY MOUTH	60.3%
SORE THROAT	56.5%
PRODUCTIVE COUGH	56.5%
MUSCLE CRAMPS	47.8%
HEADACHE	46.6%
SLEEP PROBLEMS	46.6%
CUTS/ABRASIONS	43.5%
CHILLS	37.3%
DIZZINESS	35.4%
SPRAIN OR STRAIN: UPPER BODY	34.2%
IRRITATED EYES	32.3%
SPRAIN OR STRAIN: LOWER BODY	30.4%
COLD FEET	29.2%
NONPRODUCTIVE COUGH	28.6%
STOMACH CRAMPS	28.0%
TINGLING FEET WHEN REWARMED	27.3%
UPSET STOMACH	23.6%
CONSTIPATION	22.4%
TROUBLE FOCUSING EYES	19.9%
BLURRED VISION	16.2%
PROBLEMS THINKING CLEARLY	16.2%
EARACHE	13.7%
STICKY EYES	11.2%
FEVER	11.2%
SKIN RASH	10.6%
NAUSEA/VOMITING	9.3%
SWOLLEN FEET	7.5%
ALLERGY	6.2%
DIARRHEA	5.6%
LARYNGITIS	3.7%

NOTE: The percentages are based on reports from 161 respondents.

TABLE B-2

DESCRIPTIVE STATISTICS FOR HEALTH SYMPTOM CLUSTERS

	SYMPTOMS IN CLUSTER	MEAN SCORE	S. D.	CORRELATION WITH 1	2	3	4	5	6	7
1 NONSPECIFIC	8	3.7	2.0	--						
2 GI/VIRAL	7	1.7	1.6	.51	--					
3 EYE PROBLEMS	4	0.8	1.2	.51	.24	--				
4 URI	2	1.4	0.7	.25	.28	.04	--			
5 CHILL	5	2.1	1.3	.45	.22	.28	.10	--		
6 MISCELLANEOUS	10	2.8	1.7	.60	.37	.34	.24	.48	--	
7 TOTAL SYMPTOMS	36	12.5	7.0	.87	.68	.59	.37	.63	.79	--

NOTE: All the correlation coefficients are significant at $p < .01$, except for the correlations of URI with Eye Problems and Chill.

Minor health problems were commonplace. Although none of the men in the study were evacuated from training because of their health, the importance of these problems should not be underestimated. In cold weather, even upper respiratory infection can substantially impair performance (8). Similarly, significant reductions in performance effectiveness have been demonstrated in the laboratory during mild illness (32). Finally, minor health problems may develop into more severe problems in more extreme climatic conditions or with longer exposure to the cold.

The frequency of health problems was high relative to other procedures for estimating illness rates. Sick call data from other cold weather training settings indicate that in a 3- to 4-day period between 5% to 13% of the men can be expected to visit the dispensary. Symptom reports indicate a much higher rate of health problems. The difference probably arises because many illnesses occurring in the cold are not treated in clinics (4), because symptom reporting is sensitive to relatively mild illness (16), because symptoms can reflect problems arising from work demands and other factors in addition to clinical illness, and because multiple symptoms can arise from a single illness incident.

The symptom clusters were moderately intercorrelated. Some positive correlations would be expected because symptoms assigned to one cluster might reasonably be correlated with symptoms in another cluster. For example, a viral infection might generate symptoms of "URI" and "GI/Viral." Other factors that might contribute to intercorrelations between the clusters would be reactions to the work load, altitude, etc. These points are noted because both the modest magnitude of the correlations and the presence of plausible alternative interpretations of the correlations make it less likely that the symptom reports represent primarily psychological characteristics of the individual, e.g., hypochondriasis or general sensitivity to symptom occurrence. However, this possible explanation of the findings should be kept in mind when interpreting the results of the study.

Appendix C

RECODING PROCEDURES TO DEFINE BEHAVIORAL FREQUENCY GROUPINGS USED TO ESTIMATE ASSOCIATIONS BETWEEN HEALTH MAINTENANCE BEHAVIORS AND WELL-BEING

RECODING PROCEDURES TO DEFINE BEHAVIORAL FREQUENCY GROUPINGS USED TO ESTIMATE ASSOCIATIONS BETWEEN HEALTH MAINTENANCE BEHAVIORS AND WELL-BEING

The original reports of field behaviors were recoded for the analyses relating these behaviors to well-being. The recoding procedure permitted us to compare the symptom probabilities for low and high frequency groups. This comparison provided an estimate of the effect of behavior on well-being.

The general approach to recoding was to form low, medium, and high frequency groups wherever possible. The general approach was tempered by the fact that extreme groups with very few members would be of little value for the intended analyses. Therefore, when many participants fell in a single category, the recoding was limited to forming two groups which were designated low and high for the purposes of estimating the increase in symptoms in the low frequency group. As a rough rule of thumb, an attempt was made to have a minimum of 25 to 30 participants per group. The results of applying these guideline are shown in Table C-1.

The correlations between the recoded classifications were examined to determine whether any two behaviors overlapped so extensively that reporting separate results for each would seriously distort the findings. Several associations were significant, but the extent of overlap was generally modest (see Table C-2). It was judged that there was sufficient independence of the behaviors to permit separate analyses for this exploratory study. A second reason for separate analyses for the eating habits for each MRE component was that combining the items would have generated an overall measure of "eating habits" when nutritional content may be a more appropriate concern. There was some support for this position in the fact that the reported frequency of consuming crackers was highly correlated with the reported frequency of consuming the spreads for the crackers. Despite the fact that these two behaviors produced the largest association by far, frequency of consuming the spread was a much stronger predictor of well-being than frequency of consuming the crackers (see Table 4, p. 10).

TABLE C-1
COMPLIANCE LEVEL CLASSIFICATIONS

LIQUID CONSUMPTION	
TOTAL CONSUMED	
Low:	0.25 - 2.00 Quarts/day
Medium:	2.25 - 3.50 Quarts/day
High:	4.00 - 6.00 Quarts/day
NUTRITION[a]	
MRE: MAIN COURSE	
Low:	Never, Once during the exercise, Every other day, Once a day
Medium:	Twice a day
High:	Three times a day
MRE: CRACKERS, SPREADS, CONFECTIONS, COCOA AND FRUIT	
Low:	Never, Once during the exercise, Every other day
Medium:	Once a day, Twice a day
High:	Three times a day
MRE: COFFEE	
Low:	Never
High:	Once during the exercise or more
MRE: EXTRA SALT, SUGAR	
Low:	Never
Medium:	Once during the exercise, Every other day
High:	Once a day or more
TAKING VITAMINS	
Low:	Never taken
High:	Taken once during the exercise or more
HYGIENE	
FOOT CARE[b]	
Low:	No foot care activity performed on a daily basis
Medium:	Any combination of washing feet, drying feet or using foot powder
High:	Changing socks plus any combination of washing feet, drying feet or using foot powder
SHAVING	
Low:	Never
Medium:	Once during the exercise
High:	Every other day, Once a day
CHANGE UNDERWEAR	
Low:	Never
Medium:	Once during the exercise
High:	Every other day, Once a day
BRUSHING TEETH	
Low:	Never
Medium:	Once during the exercise, Every other day
High:	Once a day, Twice a day

[a] Nutrition compliance level classifications were based on the frequency of consuming each food stuff during the exercise.

[b] Classification levels were based on the pattern of foot care activities performed on a daily basis.

TABLE C-2

TAU$_c$ VALUES FOR THE ASSOCIATION BETWEEN COMPLIANCE FOR RECOMMENDED NUTRITION AND HYGIENE STANDARDS

COMPLIANCE MEASURE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
NUTRITION														
1 Liquid Consumption														
2 Main Course	.027													
3 Crackers	.096	.195†												
4 Spreads[a]	.091	.231†	.691†											
5 Confections[b]	.054	.232†	.286†	.391†										
6 Coffee	.045	.019	.023	−.001	−.023									
7 Cocoa	.114	.012	.007	.043	.234†	.033								
8 Extra Salt	.036	−.016	.000	.012	−.046	−.015	.138‡							
9 Sugar	.096	−.021	.078	.094	−.017	.044	.224†	.172†						
10 Fruit	.008	.134**	.025	.090	.233†	−.015	.108	−.025	.049					
11 Vitamins	−.075	−.010	−.109	−.015	−.002	−.015	−.109**	.036	−.001	.025				
HYGIENE														
12 Foot Care	.157	.013	−.018	.029	.053	−.004	.038	−.015	.024	−.039	−.035			
13 Shave	−.017	.021	−.049	−.041	−.002	−.032	.093	.005	−.050	−.048	−.005	.108**		
14 Change Underwear	−.084	−.030	−.184‡	−.106	−.051	−.018	.073	−.050	−.070	−.039	.085	.133**	.363†	
15 Brush Teeth	.081	−.010	−.097	−.120**	−.091	.028	.074	.041	−.007	.105	.032	.136**	.309†	.270†

[a]Spreads included MRE contents of jelly, cheese, and peanut butter.

[b]Confections included MRE components of chocolate, caramels and nutcakes.

** $p < .05$
‡ $p < .01$
† $p < .001$

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Prior cold weather research suggests that noncompliance with medical guidelines contributes to illness in the cold. This study estimated rates of noncompliance for liquid consumption, nutrition, and foot care and provided initial assessments of the impact of each behavior on well-being. Marine volunteers (n = 161) described their behaviors and physical symptoms of illness during cold weather training. Because medical guidelines available from different sources often set different behavioral criteria, noncompliance estimates depended on the criterion selected. The range of noncompliance was 11% to

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73% for liquid consumption and 16% to 41% for foot care; 22% of the men consumed less than 3,000 calories per day compared to a guideline of 3,200. Liquid consumption and foot care were not related to well-being, but low frequency of consuming the main course, confections, and spreads in the rations was associated with 29% higher symptom reports. The absence of significant effects of foot care and liquid consumption on well-being may have been attributable to mild weather conditions and/or brief periods in the field. The potential risks associated with noncompliance appear sufficient to merit further study to specify the conditions under which noncompliance results in impaired health and performance in the cold.