

1 **PREDICTING AND EXPLAINING BEHAVIORAL INTENTION AND HAND**
2 **SANITIZER USE AMONG U.S. ARMY SOLDIERS**

3 According to the Centers for Disease Control and Prevention and the World Health
4 Organization, simple hand washing is one of the most effective methods to prevent the spread of
5 infectious diseases.^{1,2,3} The literature shows a strong and consistent association between
6 personal hand hygiene and reduced gastrointestinal disease, respiratory illness, and absenteeism
7 in the work force.^{1,4,5} Hands are the primary mode of transmission for many infectious diseases,
8 particularly among military personnel.⁶ Hand hygiene is a proven measure of controlling
9 infection in military settings.⁷

10 The lack of hand hygiene and resulting illness has economic consequences for the
11 military because of increased sick leave among soldiers and the resulting loss of training time.⁸
12 The military has acknowledged a critical need for identifying a cost-effective way of preventing
13 communicable diseases within the military ranks.^{7,8,9} Ideally, a proactive approach to preventing
14 communicable diseases would allow the military to reduce outpatient physician visits and
15 medical costs.^{7,8,10} One effective approach to preventing communicable diseases in congregate
16 settings is to implement hand sanitation programs.¹⁰

17 Implementing hand sanitation programs has significantly reduced communicable
18 diseases in many congregate settings, including schools,^{11,12} university campuses,¹³ healthcare
19 facilities,^{9,14,15,16} and military bases.^{7,17} Hand sanitizers have proved useful in decreasing
20 transmission of some resistant microorganisms and preventing cross-transmission of bacteria
21 from person to person.¹⁸ Even with alcohol-based hand sanitizers, compliance with hand
22 hygiene remains problematic.^{2,20}

23 Barriers often hinder hand hygiene compliance within the military environment.^{7,19}
24 Conflicting hand hygiene recommendations often cause confusion among military personnel

1 about what products should be used or how to best wash hands.²⁰ Little research has been
2 conducted to identify the cognitive stimulants and barriers of using hand sanitizers among
3 military personnel in the dining facility, where the possibility of hand-to-mouth transmission of
4 infection is high.

5 *The Theory of Planned Behavior*

6 The Theory of Planned Behavior (TPB) proposes that human action is guided. It predicts
7 explicit behavior, provided the behavior is intentional.²¹ The TPB has three direct variables:
8 attitudes towards the behavior, perceptions of approval by important others to performing the
9 behavior (subjective norms), and perceived behavioral control over performing the behavior. In
10 general, the more positive the attitude and subjective norm toward a behavior, the stronger the
11 perceived behavioral control, the more an individual will want to perform the behavior.²¹

12 The TPB assumes that human social behavior is reasoned or planned in the sense that
13 people take into account the likely consequences (behavioral beliefs), normative expectations of
14 important referents (normative beliefs), and whatever facilitates or impedes performance of the
15 behavior (control beliefs).²¹ Behavioral beliefs are considered the prevailing determinants of a
16 person's intentions and actions, influencing attitudes toward the behavior. Normative beliefs,
17 which establish the underlying determinants of subjective norms, explain why individuals from
18 different cultures and social categories see different social expectations. Lastly, control beliefs,
19 on which deliver perceptions of behavioral control are based, help in estimating facilitating or
20 impeding factors of behavior.²¹ Attitudes, subjective norms, and perceptions of behavioral
21 control are thought of as automatic, reasonably forming beliefs and producing a corresponding
22 behavioral intention that enables or inhibits the performance of the behavior.²¹

1 Furthermore, soldiers who absolutely intend to perform a behavior (i.e., those who score
2 a maximum intention score) differ from those who are not firmly committed (i.e., those with less
3 than a maximum intention score).²² According to the transtheoretical model of behavior change,
4 we must differentiate between soldiers with absolute intention of performing behaviors and those
5 with less intention to do so across qualitatively distinct motivational stages, then researchers can
6 begin to explain how soldiers differ in their beliefs about using hand sanitizer.²²

7 As TPB suggests, the purpose of this study was to explore the cognitive stimulants and
8 barriers to using hand sanitizer among soldiers in the dining facility. Specifically, this study
9 explores the behavioral intention (low and absolute), attitude with behavioral beliefs, subjective
10 norm with normative beliefs, and perceived behavioral control with control beliefs towards hand
11 sanitizer use among U.S. Army soldiers.²¹

12 *Hypotheses*

13 The hypotheses to test specific objectives are listed below:

14 H₁: Behavioral beliefs about hand sanitizer are significantly associated with attitudes
15 about hand sanitizer.

16 H₂: Normative beliefs about hand sanitizer are significantly associated with subjective
17 norms about hand sanitizer.

18 H₃: Control beliefs are positively associated with perceived behavioral control in using
19 hand sanitizer.

20 H₄: A soldier's attitude about hand sanitizers is significantly and positively related to
21 their behavioral intention.

22 H₅: A soldier's subjective norm about hand sanitizer is significantly and positively
23 related to their behavioral intention.

1 H₆: A soldier's perceived behavioral control about hand sanitizer is significantly and
2 positively related to their behavioral intention.

3 **METHODOLOGY**

4 *Participants, Setting and Measures*

5 The population of interest in this study was non-trainee soldiers stationed at one of largest
6 U.S. Army bases in the Midwest. The participating army facility and the university institutional
7 review board approved the study protocol. The initial questionnaire was created using a
8 literature review and previous health research guidelines to define the target behavior using
9 action, target, context, and time.²³ The questionnaire included both direct belief measures and
10 indirect belief measures, both assessed using a survey of 41 scaled questions and demographic
11 items.

12 Direct belief measures are attitude, subjective norms, perceived behavioral control,
13 behavioral intention, and self-reported behavior. Three items of attitude were measured based on
14 endorsement, likeliness, and provability. "*Using hand sanitizer is a good idea*" is an example
15 attitude that was measured. Three items of subjective norms were drawn from important people,
16 social pressure, and general expectation. One example of such items used to measure subjective
17 norms is "*It is expected that I will use hand sanitizer before each meal*". Perceived behavioral
18 control was measured using three items from confidence, self-efficacy, and ease of use. As an
19 example, "*I am confident that I can use hand sanitizers whenever I want to*". Behavioral
20 intention was measured using four items similar to "*I want to use hand sanitizer every day*".
21 Finally, self-reported behavior was measured using two items; an example is "*I use a hand
22 sanitizer every day before meals*".

1 Indirect belief measures included constructs from behavioral beliefs, normative beliefs,
2 and control beliefs with related outcome evaluations. A total of six questions of behavioral
3 belief strength with related outcome evaluations of strength was measured. Example questions
4 are “*If I use hand sanitizer every day, I will be less likely to become ill*” and “*It is very important*
5 *for me to avoid illness*”. Normative beliefs were measured using eight questions. Example
6 questions are “*Other soldiers think that I should use hand sanitizer*” and “*Doing what other*
7 *soldiers do is important to me*”. Lastly, six items measured control belief, specifically control
8 belief strength and control belief power. A set of example questions include “*The hand sanitizer*
9 *dispenser is difficult to find*” and “*I am more likely to use hand sanitizer if it is easily available*”.
10 All direct and indirect variables were measured with a seven-point Likert scale, ranging from 1
11 (*strongly disagree*) to 7 (*strongly agree*).

12 *Procedure (pilot phase and final phase)*

13 Two pilot studies were conducted before the main study. Before pilot study one, a panel
14 of five experts and veterans checked the face validity of the questionnaire. The group made
15 recommendations for questionnaire wording and layout.

16 The first pilot study was conducted with soldiers at a dining facility on the military base.
17 A total of 40 copies of the survey were distributed, 18 copies with valid answers were returned,
18 for a response rate of 45%. Based on feedback from participants in the first pilot study, the cover
19 page was revised to ensure instructions on how to complete the survey were clear and to
20 highlight that all collected data remained anonymous. The second pilot study was conducted at a
21 second dining facility during lunch hour. A total of 50 copies of the survey were distributed, and
22 17 copies with valid answers were returned, for a response rate of 30%. After the second pilot

1 study, the survey was modified into booklet form for easy accessibility with a quick response
2 code and web address linked to online duplicates of the paper survey to encourage participation.

3 The final paper survey introduced participants to the purpose of the study with
4 instructions on how to complete the survey. A cover letter with the three-page questionnaire was
5 printed and distributed to soldiers as they arrived at the dining facility during lunch hours (11:00
6 A.M. - 1:00 P.M.). If the soldiers preferred to complete the questionnaire online, the provided
7 website link or a quick response code directed the participants to the electronic version of the
8 survey. During the main data collection period, a total of 550 surveys were distributed with
9 complimentary snacks as incentives to encourage responses. Several data collectors ensured that
10 each soldier could be targeted when they entered the facility. Data collectors gathered the
11 surveys as soldiers left the facility, and a collection box was also available.

12 *Sample size*

13 Of the 550 surveys distributed, 255 were collected on-site, with 10 collected online.
14 After purging those that were incomplete, those with a plotted response, or questionnaires
15 submitted by non-active duty soldiers, the final number of surveys collected was 201 (40%
16 response rate). Using the statistical sample size estimator, this study achieved a medium
17 heterogeneity at 95% confidence level with a minimum confidence level of 89.5%.^{21,25}

18 *Statistical analysis*

19 All data analysis used the Statistical Package for the Social Sciences (SPSS) (version
20 21.0). Double entry comparison was used to ensure input validity. Descriptive statistics were
21 used to explain the mean and standard deviation of all direct and indirect belief items.
22 Cronbach's alpha was used to determine the internal reliability of all seven constructs.²⁴ A
23 threshold of 0.70 was used to demonstrate internal consistency. Simple linear regressions were

1 used to identify the correlation between each TPB indirect measure (behavioral belief, normative
2 belief, and control beliefs) and its related TPB direct measure (attitude, subjective norms, and
3 perceived behavioral control). Multiple linear regressions were used to regress the TPB direct
4 measure variables (attitude, subjective norms, and perceived behavioral control) on behavioral
5 intention. Independent t-tests were conducted to test the differences in beliefs between absolute
6 intenders and lower intenders.

7 **RESULTS**

8 Of the 201 surveys collected, 186 were male (92.5%), 15 were female (7.5%). Most were
9 18 to 34 (92.5%, mean = 27.4); 72% of the respondents had household incomes less than
10 \$30,000 per year. Most were single (83.6%) with a high school education (70%).

11 A descriptive summary of individual belief items describes mean and standard deviation
12 in terms of behavioral strength and evaluation with that beliefs in Table 1. After an initial
13 review, two behavioral belief items “*It causes a lot of worry and concern for me to use hand*
14 *sanitizer*” and “*Causing a lot of worry and concern for me is desirable*” were removed from
15 further analysis because the response rate was low, and those responses we did receive had low
16 reliability.

17 Principal component factor analysis with varimax rotation was conducted on all major
18 TPB constructs. Based on a minimum eigenvalue of 1.0, the direct measurements of attitude,
19 subjective norm, perceived behavioral control, behavioral intention, self-reported behavior, and
20 indirect measurements of normative, behavioral, and control beliefs all yield one factor within
21 each variable. The means, standard deviations, and intercorrelations for all study variables are
22 presented in Table 2. We found a strong correlation between the attitudes, subjective norms,
23 perceived behavioral control and behavior, normative, and control beliefs items.

Table 1. Descriptive Summary of Belief Items (N = 201)

Belief Items	Strength Mean ± SD ^a	Evaluation Mean ± SD ^b	Overall Beliefs Mean ± SD ^c
Behavioral Beliefs (a = 0.75)			
	bb _i [*]	be _i [*]	bb _i be _i [*]
To do something positive for myself	5.2 ± 1.6	2.0 ± 1.2	10.9 ± 7.7
To avoid illness	4.9 ± 1.6	1.9 ± 1.5	10.3 ± 8.0
Composite Score	10.1 ± 3.2	3.9 ± 2.7	24.0 ± 16.2
Normative Beliefs (a = 0.82)			
	nb _i [*]	mc _i [*]	nb _i mc _i [*]
My family and friends	4.5 ± 1.6	1.2 ± 1.6	6.6 ± 7.5
Doctor and nurses	5.5 ± 1.4	1.0 ± 1.5	6.4 ± 9.0
Army leadership	4.9 ± 1.5	0.9 ± 1.8	5.2 ± 9.7
Other soldiers	4.3 ± 1.6	-0.4 ± 1.8	-0.8 ± 8.5
Composite Score	19.2 ± 6.1	2.7 ± 6.7	17.4 ± 28.0
Control Beliefs (a = 0.73)			
	cb _i [*]	ppi _i [*]	cb _i ppi _i [*]
Availability of hand sanitizers	3.7 ± 1.9	1.4 ± 1.5	5.7 ± 7.0
Cause dry skin	3.5 ± 1.8	0.4 ± 1.7	3.2 ± 5.5
Smell of hand sanitizer	3.0 ± 1.7	0.9 ± 0.9	2.1 ± 6.5
Composite Score	10.2 ± 5.4	2.7 ± 4.1	11.0 ± 15.4

^a Strength means were measured on a 1 to 7 scale, SD = Standard Deviation.

^b Evaluation means were measured on a -3 to +3 scale.

^c Overall belief mean represents the mean of each strength item multiplied by each of the responding evaluation items; total score possible ranged from - 21 to + 21.

* Note: bb = Behavioral Beliefs, be = Behavioral Beliefs, nb = Normative Beliefs, mc = Motivation to Comply, cb = Control Beliefs, pp = Perceived Power

Table 2. Simple Bivariate Correlation Matrix (N = 201)

Variable	M	SD	1	2	3	4	5	6	7	8
1. Behavioral Beliefs	24.0	16.1	1.0	0.4**	0.2*	0.6**	0.3**	0.3**	0.5**	0.4**
2. Normative Beliefs	17.4	28.0		1.0	0.2**	0.5**	0.5**	0.3**	0.4**	0.5**
3. Control Beliefs	11.0	15.0			1.0**	0.4**	0.2**	0.4**	0.4**	0.3**
4. Attitude	16.5	3.9				1.0	0.5**	0.3**	0.8**	0.6**
5. Subjective Norms	12.0	4.5					1.0	-0.1	0.5**	0.7**
6. PBC	17.7	3.2						1.0	0.2**	0.2*
7. BI	20.0	6.2							1.0	0.7**
8. SRB	8.7	3.3								1.0

Note: BI = Behavioral Intention; PBC = Perceived Behavioral Control; M = Mean; SD = Standard Deviation; SRB = Self-reported Behavior

**p < .01; and *p < .05 (all two-tailed).

1 Simple linear regressions were used to test the hypotheses (H₁, H₂, and H₃) for
 2 significance. All three hypotheses were supported. The correlation coefficients of the
 3 behavioral beliefs on attitude (H₁, $r = 0.6$, $F = 129.8$, $\rho < .01$), normative beliefs on subjective
 4 norm (H₂, $r = 0.5$, $F = 66.2$, $\rho < .01$), and control beliefs on perceived behavioral control (H₃, $r =$
 5 0.1 , $F = 30.5$, $\rho < .01$) were all significant.

6 Multiple linear regression was used to test hypotheses H₄, H₅, and H₆ as presented in
 7 Table 3. The multiple regressions of attitude (H₄, $\beta = .70$, $\rho < .01$) and subjective norm (H₅, $\beta =$
 8 $.18$, $\rho < .01$) on behavioral intention were significant, with the overall regression model
 9 explaining 64% of the total variance within behavioral intention ($F = 117.1$, $R_a^2 = 0.64$) with
 10 small to medium effect size ($f^2 = 0.24$).

11 An independent sample t-test was used to differentiate indirect beliefs among soldiers
 12 who have low intention to use hand sanitizer and those with an absolute intention to do so (i.e.,
 13 those who score a maximum intention score) (Table 4). Soldiers with an absolute intention to
 14 use hand sanitizer have significantly stronger attitudinal beliefs ($p < .01$) and stronger social

Table 3. Multiple Regression Model for Predicting Behavioral Intention Based on Direct Measures

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	4953.3	3	1651.1	117.1	0.00
Residual	2748.7	195	14.1		
Total	7702.0	198 ^a			

Standardized Coefficients			
Model	Beta	t	Sig.
(Constant)		-0.70	0.49
Attitude	0.70	13.49	0.00
Subjective Norm	0.18	3.84	0.00
Perceived Behavioral Control	-0.01	-0.10	0.92

16 Note: Dependent Variable, Behavioral Intention; df = degree of freedom; F = F-statistic; Sig = Significance; T = T-statistic
 17 ^a Total intender may not equal to $N = 201$ due to non-response to questions.

18

Table 4. Means, Standard Deviation, and Independent Samples T-Test of Behavioral Beliefs among Soldiers with Lower Intention and Absolute Intention to Perform Hand Sanitation Behaviors (N = 201)

Behavioral Belief Items	Hand Sanitation Behavior (Mean ± Standard Deviation)				F	Sig.	T- Test (N = 201) ^a		
	Overall (N = 201) M ± SD	Lower Intenders (n = 172) ^a M ± SD	Absolute Intenders (n = 28) ^a M ± SD				t	df	95% CI
Overall Attitude Beliefs	24.0 ± 16.2	5.3 ± 1.3	6.8 ± 0.5	21.8	0.00	-12.0	110.7	[-1.82, -1.30]	
To do something positive for myself	10.9 ± 7.7	9.4 ± 7.1	19.6 ± 4.2	19.1	0.00	-10.5	55.7	[-12.11, -8.22]	
To avoid illness	10.3 ± 8.0	8.7 ± 7.6	19.4 ± 7.2	1.3	0.15	1.5	32.9	[-0.79, 5.03]	
Overall Subjective Norm Beliefs	17.4 ± 28.0	3.8 ± 1.4	5.1 ± 1.6	0.871	0.00	-4.0	33.5	[-1.97, -0.63]	
My family and friends	6.6 ± 7.5	5.7 ± 6.7	12.5 ± 9.2	1.4	0.00	-3.6	33.3	[-11.49, -3.23]	
Doctor and nurses	6.4 ± 9.0	5.3 ± 8.5	12.7 ± 10.2	2.9	0.01	-2.8	32.3	[-2.77, -1.81]	
Army leadership	5.2 ± 9.7	4.3 ± 9.0	10.8 ± 11.8	7.6	0.00	-3.7	31.8	[-3.95, -3.11]	
Other soldiers	-0.8 ± 8.5	-1.3 ± 7.5	2.2 ± 12.9	19.6	0.18	-1.4	30.0	[-0.04, 1.67]	
Overall Control Beliefs Items	11.0 ± 15.4	5.8 ± 1.0	6.3 ± 1.2	0.950	0.95	-2.1	33.3	[-1.03, -0.02]	
Availability of hand sanitizers	5.7 ± 7.0	5.6 ± 6.9	6.8 ± 8.2	2.1	0.42	-0.8	33.4	[-4.64, 1.98]	
Dries out my hands	3.2 ± 5.5	1.8 ± 6.1	3.9 ± 8.0	0.1	0.12	-1.6	35.7	[-4.13, 0.50]	
Smell of hand sanitizer	2.1 ± 6.5	2.9 ± 5.5	4.8 ± 5.6	2.5	0.19	-1.3	32.4	[-5.31, 1.10]	

Note: The absolute intender category represents employees scoring strongly agree on behavior intention to use hand sanitizer, and the lower intender category represents employees with who scored less strongly to use hand sanitizer.

Note: The possible range of scores for all individual indirect belief entries (all except those labeled “Overall”) is -21 to +21, with a higher number indicating a more positive belief.

Note: The possible range for overall attitude is -42 to + 42, subjective norm is -84 to +84, and perceived behavioral control is -63 to +63.

Note: F = F-statistic; Sig. = significance level; t = t-statistic df = degree of freedom; CI = confidence interval

^a Total intender may not equal 100% if no response was given to questions.

1 norms ($p < .01$) than soldiers with low intention to use hand sanitizer, but perceived relatively the
2 same amount of behavioral control as soldiers with low intention to use hand sanitizer. More
3 specifically, soldiers with absolute intentions to use hand sanitizers hold significantly higher
4 positive attitudes ($p < .01$), have significant more perceived social support from families ($p <$
5 $.01$), health professionals ($p < .01$), and from their leadership ($p < .01$) than soldiers with lower
6 intentions to use hand sanitizer.

7 **DISCUSSION**

8 *Importance of attitude and social inferences in the use of hand sanitizer*

9 Attitudes were the strongest predictor among all variables. Our results confirmed a
10 positive linear relationship between overall behavioral beliefs and the attitude in the use of hand
11 sanitizer. By explaining and measuring behavioral beliefs related to attitude, we gain insight into
12 what guides a soldier's decision to use hand sanitizer. Two of the behavioral beliefs "*to do*
13 *something positive for myself*" and "*to avoid illness*" were among the most important attitudinal
14 constructs for a strong attitude. It should be noted that although these beliefs are strong among
15 soldiers, they could be still stronger. For example, using volitional and motivational intervention
16 that targets the efficacy and positivity of hand sanitizer use will likely promote behavioral
17 beliefs, and thus effectively improve hand sanitation among soldiers.

18 The intention to use hand sanitizers among soldiers was guided by subjective norms. The
19 results also showed that overall normative beliefs were positively related to the subjective norms
20 of soldiers using hand sanitizer. By identifying and measuring the specific normative beliefs
21 within the military population, we identified three normative beliefs (family and friends,
22 healthcare professionals, and Army leadership) as important in guiding the decision to use hand
23 sanitizer. However, other soldiers provided negative normative belief, indicating soldiers felt a

1 negative social influence from their peers. Specifically, soldiers are willing to act out of the
2 norm and separate themselves from their peers. In practice, changing these normative beliefs
3 and motivating soldiers to act indifferently from their peers will effectively change their
4 perceived social norms, thus enhancing the intention to use hand sanitizer. Some of these
5 referent groups (e.g., family and friends) could be used to encourage positive normative beliefs
6 to mitigate any negative influences to soldiers using hand sanitizer.

7 *Importance of targeting specific beliefs during behavior change*

8 This study identified specific behavioral beliefs underlying the attitudes, subjective
9 norms, and perceived behavioral control among soldiers who absolutely intend to perform the
10 behaviors and those with low intention to do so. Specifically, absolute intenders were more
11 likely to consider hand sanitation as positive and perceive significant different social inferences
12 than lower intenders. These beliefs can be targeted in intervention studies to improve cohort
13 strategies by using the significant predictors of behavioral intentions (i.e., attitudes, subjective
14 norms, or perceived behavioral control). To bring all soldiers' beliefs in line with those who
15 already intend to use hand sanitizer would be an important stage of change that could lead to
16 better operational intentions and eventually compliance with hand sanitation behaviors. For
17 soldiers to contemplate intention to use hand sanitizer involves improving attitude, and
18 interventions should target the behavioral belief that stresses the positive aspects of using hand
19 sanitizers (e.g., using the hand sanitizers helps reduce the spread of microorganisms and reduces
20 the possibility of getting sick). Targeting subjective norms is also important, and interventions
21 should emphasize that family, friends, doctors, and commanders want soldiers to use hand
22 sanitizers more. Healthcare professionals and army leaders can help improve the behavioral
23 intention to use hand sanitizers by focusing on positive normative beliefs while reducing the

1 effect of the negative motivation from other soldiers. This can be done by focusing not on
2 individual soldiers, but on the benefits to the army as a whole, which should eventually improve
3 the preventive control structures within the military.

4 *Limitations*

5 All data were collected on one military installation over a relatively short time (less than
6 three weeks), and the current study used only self-reported behavior of hand sanitizer use.
7 Future studies could gather aggregated data from past and actual behavior to enrich the current
8 model and better explain the beliefs items related to behavioral stage information. In addition,
9 using the self-reported survey introduces some of the commonly perceived social psychology
10 biases like memory bias, thus improving the accuracy of the instrument will likely improve the
11 quality and validation of the study of hand sanitation behavior.

12 **CONCLUSION**

13 This study has explained 64% of the variance in the determinants of behavioral intention
14 to use hand sanitizer among soldiers and supported the significant relationship between the
15 attitudes of soldiers toward the use of hand sanitizer and subjective norms. More specifically,
16 we have examined various specific beliefs that affect hand sanitation behavior. These specific
17 beliefs (behavioral, normative, and control), if targeted during interventions, can improve
18 compliance with intention, and thus enhance current disease prevention within the military
19 environment. Although past studies^{1,9,18,24,25} have demonstrated the importance of hand hygiene
20 in the military, our study has identified the important behavioral factors that can help improve
21 behavior that prevents illness in the military and helps the military create control structures that
22 encourage use of hand sanitizers.

1 This study is among the very few to systematically explore the stimuli and barriers
2 soldiers see in using hand sanitizers. The U.S. military places a high value on the health of their
3 personnel. The results of this study can help healthcare professionals and military leaders
4 improve current preventive control guidelines by targeting specific behavioral beliefs related to
5 the intention to use hand sanitation devices like hand sanitizers. Practical implications will likely
6 translate into reduced health care costs, improved mission readiness, and the overall health of the
7 military.

8 **REFERENCES**

- 9 1. Centers for Disease Control and Prevention. Vital signs: Incidence and trends of infection
10 with pathogens transmitted commonly through food--foodborne diseases active surveillance
11 network, 10 U.S. sites, 1996-2010. *Morb Mortal Wkly Rep* 2011, 60: 749-755.
- 12 2. Larson, E. L. Association for Professionals in Infection Control and Epidemiology (APIC)
13 guidelines for handwashing and hand antisepsis in health care settings. *Am J Infect Control*
14 1995, 23: 251-269. doi: 10.1016/0196-6553(95)90070-5
- 15 3. World Health Organization. First Global Patient Safety Challenge. WHO Guidelines on
16 Hand Hygiene in Health Care 2009. Geneva [Switzerland]: WHO Press; 2009.
- 17 4. Hall, A. J., Wiksw, M. E., Pringle, K., Gould, H., & Parashar, U. D. Vital Signs: Foodborne
18 Norovirus Outbreaks-United States, 2009-2012. *Morb Mortal Wkly Rep* 2014, 63: 491-495.
- 19 5. Sandora, T. J., Taveras, E. M., Shih, M. C., Resnick, E. A., Lee, G. M., Ross-Degnan, D., &
20 Goldmann, D. A. A randomized, controlled trial of a multifaceted intervention including
21 alcohol-based hand sanitizer and hand-hygiene education to reduce illness transmission in the
22 home. *Pediatrics* 2005, 116: 587-594.
- 23 6. Kolavic-Gray, S. A., Binn, L. N., Sanchez, J. L., Cersovsky, S. B., Polyak, C. S., Mitchell-
24 Raymundo, F., ... Innis, B. L. Large epidemic of adenovirus type 4 infection among military
25 trainees: Epidemiological, clinical, and laboratory studies. *Clin Infect Dis* 2002, 35: 808-818.
- 26 7. Mott, P. J., Sisk, B. W., Arbogast, J. W., Ferrazzano-Yaussy, C., Bondi, C. A. M., &
27 Sheehan, J. J. Alcohol-based instant hand sanitizer use in military settings: A prospective
28 cohort study of army basic trainees. *Mil Med* 2007, 172: 1170-6.
- 29 8. Russell, K. L., Hawksworth, A. W., Ryan, M. A., Strickler, J., Irvine, M., Hansen, C. J., . . .
30 Gaydos, J. C. Vaccine-preventable adenoviral respiratory illness in US military recruits,
31 1999-2004. *Vaccine* 2006, 24: 2835-2842. doi: 10.1016/j.vaccine.2005.12.062
- 32 9. Riddle, M. S., Murray, J. A., Cash, B. D., Pimentel, M., & Porter, C. K. Pathogen-specific
33 risk of celiac disease following bacterial causes of foodborne illness: a retrospective cohort
34 study. *Dig Dis Sci* 2013, 58: 3242-3245.
- 35 10. Aiello, A. E., Coulborn, R. M., Perez, V., & Larson, E. L. Effect of hand hygiene on
36 infectious disease risk in the community setting: a meta-analysis. *Am J Public*
37 Health 2008, 98: 1372-1381.

- 1 11. Dyer, D. L., Shinder, A., & Shinder, F. Alcohol-free instant hand sanitizer reduces
2 elementary school illness absenteeism. *Fam Med* 2000, 32: 633-638.
- 3 12. Hilburn, J., Hammond, B. S., Fendler, E. J., & Groziak, P. A. Use of alcohol hand sanitizer
4 as an infection control strategy in an acute care facility. *Am J Infect Control* 2003, 31: 109-
5 116. doi: 10.1067/mic.2003.15
- 6 13. White, C. G., Shinder, F. S., Shinder, A. L., & Dyer, D. L. Reduction of illness absenteeism
7 in elementary schools using an alcohol-free instant hand sanitizer. *J Sch Nurs* 2001, 17: 248-
8 265.
- 9 14. Bischoff, W. E., Reynolds, T. M., Sessler, C. N., Edmond, M. B., & Wenzel, R. P.
10 Handwashing compliance by health care workers: The impact of introducing an accessible,
11 alcohol-based hand antiseptic. *Arch of Intern Med* 2000, 160: 1017-1021.
- 12 15. Eaton, L. Hand washing is more important than cleaner wards in controlling. *BMJ* 2005, 330:
13 922.
- 14 16. White, C., Kolble, R., Carlson, R., Lipson, N., Dolan, M., Ali, Y., & Cline, M. The effect of
15 hand hygiene on illness rate among students in university residence halls. *Am J Infect*
16 *Control* 2003; 31: 364-370.
- 17 17. Ryan, M. A., Christian, R. S., & Wohlrabe, J. Handwashing and respiratory illness among
18 young adults in military training. *Am J of Prev Med* 2001, 21: 79-83.
- 19 18. Antoniak J. Handwashing compliance: A tertiary Canadian-accredited hospital in the middle
20 east promotes a multidisciplinary approach to address the challenges of handwashing
21 compliance. *Can Nurse* 2004, 100: 21-25.
- 22 19. Larson, E., & Kretzer, E. Compliance with handwashing and barrier precautions. *J Hosp*
23 *Infect* 1995, 30: 88-106.21.
- 24 20. Ajzen, I. The theory of planned behavior. *Organ Behav Hu Decis Process* 1991, 50: 179-211.
- 25 21. Fishbein, M., & Ajzen, I. Predicting and changing behavior: The reasoned action approach.
26 Abingdon [UK]: Taylor & Francis; 2011.
- 27 22. Prochaska, J. O. Transtheoretical model of behavior change. *Encyclopedia of behavioral*
28 *medicine*. New York [NY]: Springer; 2013.
- 29 23. Francis, J. J., Eccles, M. P., Johnston, M., Walker, A., Grimshaw, J., Foy, R., et al.
30 Constructing questionnaires based on the theory of planned behaviour. *A Manual for Health*
31 *Services Researchers*, 2010. Newcastle upon Tyne [United Kingdom]: University of New
32 Castle; 2010.
- 33 24. Dillman, D. A. *Mail and Internet Surveys: The tailored design method--2007 update with*
34 *new Internet, visual, and mixed-mode guide*. New York [New York]: Wiley; 2011.

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