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Hand hygiene performance and beliefs among public university employees

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Abstract

The workplace is an important location to access community members, and employers have a direct interest in employee well-being. A survey administered to a random sample of employees at a Midwestern US university tested the ability of a model informed by the theory of planned behavior to predict hand hygiene practices and beliefs using structural equation modeling. Questions demonstrated acceptable validity and reliability. Constructs predicted self-reported hand hygiene behaviors, and hand hygiene behaviors reduced the odds of reporting sickness from respiratory tract and gastrointestinal infections. The findings support multi-modal hand hygiene improvement interventions.

Keywords

employees, hand hygiene, health promotion, infectious disease, theory of planned behavior

Introduction

Employers have a compelling interest to reduce infectious disease including influenza, the common cold, and gastrointestinal (GI) infections. They pay for the direct costs of absenteeism in employee wages and indirect costs for overtime pay, replacement staff, and reduced quality of services. US employers bear the costs of escalating health premiums and, if self-insured, the direct costs of health claims. The World Health Organization (WHO, 2013) estimates an annual global influenza attack rate of 5-10 percent for adults and 20–30 percent for children, while the National Institutes of Health (2011) approximates an annual influenza rate of 5 percent–20 percent. In addition, the average annual number of common cold cases range between 2 and 4 for adults and 6 and 8 for children (Heikkinen and Järvinen, 2003; Monto et al., 2001). Outcomes include deaths, hospitalizations, outpatient visits, absenteeism from work, and lost productivity. US costs for seasonal influenza and the common cold are estimated at US$87.1 billion (Molinari et al., 2007) and US$40 billion (Fendrick et al., 2003), respectively. Although GI infections are less well quantified, roughly 210,000,000 cases occur each year in the United

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States, of which, 64 percent are nonfoodborne in origin (Mead et al., 1999), while an estimated 9.4 million annual cases occur in the United Kingdom, translating to one out of five people, of which, 50 percent are nonfoodborne (Wheeler et al., 1999). One study found that those who reported experiencing GI infections had a sixfold greater risk of consultation with their physicians at 3 months post infection and a sixfold increased risk of developing irritable bowel syndrome (Cumberland et al., 2003).

Hands contaminated with pathogens from surfaces or direct contact with humans or animals are an important source of transmission for GI, respiratory, and skin infections since they come directly into contact with portals of entry through the mouth, nose, and conjunctiva of the eyes (Bloomfield et al., 2007). Two meta-analyses showed that hand hygiene improvement interventions reduced the risk of GI disease by 42 percent–47 percent (Curtis and Cairncross, 2003) and respiratory infection by 16 percent (Rabie and Curtis, 2006). The authors of these meta-analyses concluded that although the number and quality of studies were limited, the evidence showed a clear, consistent pattern of protection from hand hygiene improvement interventions and called for additional trials with greater rigor. A third meta-analysis found that hand hygiene enhancement interventions reduced respiratory and GI infections in community settings, such as schools, day care, and homes, by 21 and 31 percent, respectively (Aiello et al., 2008).

Hand hygiene and respiratory hygiene are recommended by the WHO as strategies to prevent pandemics and severe acute respiratory syndrome (Gostin, 2006; Lau et al., 2004). The CDC (CDC, 2013a) advocates a three-tiered approach in the workplace to reduce seasonal influenza: implementing vaccination campaigns, performing hand hygiene and respiratory hygiene, and educating workers to recognize early symptoms of influenza and to stay home when sick. Vaccines among working populations have substantially reduced influenza-like illness episodes, along with related work loss and health-care provider visits (Nichol et al., 2009). However, in the event of a pandemic, hand hygiene and respiratory hygiene are likely to become a first line of defense to slow the spread of disease until vaccines become available (Bell et al., 2006; Bloomfield et al., 2007). Protective hand hygiene practices are needed as an additional measure to reduce the transmission of infections that are not induced by the influenza virus, such as the common cold and GI infections.

Hand hygiene community guidelines have been issued in the United States (CDC, 2013b). Community members can be reached in the workplace since employees are a captive audience, spending up to half of their waking hours at work. In addition, close proximity during working hours may contribute to the spread of infections. However, to date, only three peer-reviewed articles have reported hand hygiene interventions with general employees, beyond workers who are required to perform hand hygiene to minimize risk to themselves and the public. One study found a 10% reduction in teacher absenteeism as a secondary aim in a hand hygiene improvement intervention that was designed to reduce illness among elementary students (Hammond et al., 2000). A second study among workers in a German public administration setting found 65 percent reduced odds of self-reported illness from the common cold (Hubner et al., 2010). While both of these interventions utilized alcohol-based hand sanitizer in addition to soap and water, a third study among Finnish workers found a 6.7 percent reduction in infections among workers in the intervention arm that consisted of education and soap and water (Savolainen-Kopra et al., 2012).

Hand hygiene behavior change is complex, and interventions are more likely to be effective if they are informed by behavioral motivations (Glanz et al., 2008; Pittet, 2004). A paucity of information exists about the hand hygiene motivations and behavior of workers and how, if at all, these may differ from the general public. The Theory of Planned

Behavior (TPB) has been used successfully to guide health behavioral interventions among the public since the mid-1980s (Ajzen, 1991; Montano and Kasprzyk, 2002). More specifically, the theory has been used to gain understanding about hand hygiene performance and motivations among health-care professionals (The Joint Commission, 2009) and professional caterers (Clayton and Griffith, 2008). The TPB postulates that beliefs underlie attitudes, subjective norms, and perceived behavioral control, which together influence intention and behavior. These beliefs include beliefs about the outcome of the behavior (behavioral beliefs, corresponding to attitudes); beliefs about the perception of expectations regarding the behavior (normative beliefs, corresponding to subjective norms); and beliefs about the extent to which individuals can control the performance of the behavior (control beliefs, corresponding to perceived behavioral control).

Stedman-Smith et al. (2012) administered a pilot survey based on a modified TPB model to workers from 39 bank branches to test the capacity of the TPB to guide understanding about knowledge, beliefs, and practices of self-reported hand hygiene behavior as a prelude to a planned worksite hand hygiene intervention. Findings revealed that behavioral beliefs and normative beliefs were predictive of self-reported hand hygiene performance. However, since these findings were derived from a relatively small convenience sample of 159 workers, generalizability was limited.

Purpose

The purpose of this study is twofold: (1) to utilize a larger, random sample of workers in a public university setting to determine whether a modified model of the TPB generates understanding about hand hygiene beliefs and practices, as well as predicts self-reported hand hygiene behavior, self-reported infectious disease and related absenteeism and (2) to inform the development of interventions among employees in similar public work settings.

Methods

Procedure and measures

A voluntary, anonymous survey was administered online to a randomly selected sample of 1600 full-time employees from a Midwestern US university of 5504 workers. Employees received an email that encouraged participation. A hyperlink led to the opening screen of the survey that provided informed assent. At the end of the questionnaire, an additional link took participants to a secure website on a different server to enter a drawing for a US$10 gift card. The survey was open from 7 March 2012 to 2 April 2012; data analysis was performed in the summer and fall of 2012. The study was approved by the University's Institutional Review Board.

Four major TPB-related constructs were measured using 5-point Likert scales: response options were strongly agree (5), agree (4), somewhat agree (3), disagree (2), and strongly disagree (1). These included self-reported hand hygiene practices (behavior) and four distinct beliefs: benefits of performing hand hygiene (behavioral beliefs), normative expectations of others (normative beliefs), and behavioral control (control beliefs). Because we wanted to understand workers' perceptions pertaining to when hand hygiene is needed, a fourth construct, beliefs about protective practices, was measured. Four out of these five constructs have previously shown satisfactory validity and reliability (Stedman-Smith et al., 2012). Questions were informed by United States Centers for Disease Control and Prevention (US CDC) (2013b) community hand hygiene guidelines and scientific literature (Boone and Gerba, 2007). Additionally, one question assessed intention. Intention was not directly measured as a complete construct with three or more items due to constraints on the length of the survey. Consistent with the model used by Sax et al. (2007), it was indirectly measured through the outcome of self-reported hand hygiene behaviors.

Hypotheses were threefold. First, construct validity would be demonstrated for all major latent constructs. Second, beliefs would predict self-reported hand hygiene behaviors. Third, hand hygiene behaviors would predict self-reported symptoms of the common cold/influenza-like illness or GI infections during the past 30 days.

Analyses

Descriptive statistics measured demographics, usual self-reported hand hygiene behaviors, and perceived beliefs about hand hygiene. To establish construct validity, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were employed. First, EFA was conducted using all survey questions. Since the latent factors are expected to be related, Promax rotation, an oblique rotation method that permits factors to correlate, was utilized. The number of common factors to extract was determined by examining the scree plot of the eigenvalues for each factor to identify the "breakpoint" where the curve flattens out (Costello and Osborne, 2005).

Several item loading tables of extracted factors from near the breakpoint were examined. The best factor structure was defined as the table in which the largest number of items were loaded onto single factors strongly (values above 0.30), along with the smallest number of cross-loading items. Next, CFA was conducted to establish the convergent and discriminant validity of these factors. Factor loadings represented a measure of convergent validity of the survey items onto latent factors, while correlations between the factors served as measures of discriminant validity by demonstrating enough independence between the factors to declare each factor to be a separate latent construct (Kline, 1998). Evidence of convergent validity was seen in statistically significant item loadings with standardized values greater than 0.40. Discriminant validity was observed in the correlations among latent constructs that did not exceed 0.80 (Floyd and Widaman, 1995). Finally, Cronbach's alpha was calculated to determine the internal consistency reliability of each remaining construct.

Relationships between constructs were modeled using structural equation modeling (SEM). In the structural part of the model, paths were specified where all hand hygiene belief constructs and demographic characteristics were regressed on hand hygiene behaviors, and hand hygiene behaviors and demographic characteristics were regressed in a logistic model on the dichotomous variable that combined participant self-reported cold/influenza-like illness and GI infection during the past 30 days. Within SEM, statistical tests and standardized coefficients for continuous latent variables and odds ratios for the dichotomous illness outcome variable were calculated. Evaluation of the goodness of fit of both the CFA and SEM models was assessed using the Tucker–Lewis index (TLI) and the root mean square error of approximation (RMSEA) (Hu and Bentler, 1999).

Missing data from survey respondents varied substantially across variables, with no missing data for initial survey items (0%–18%) and increasing substantially among the demographic variables at the end of the survey (5%–51%). To assess the missingness mechanism of the data, the above analyses were conducted three times. The first was conducted with subjects who had no missing data, effectively assuming that data were completely missing at random (CMAR). The second analysis was done with 10 imputations of the data set created using a sequential regression multiple imputation method (Raghunathan et al., 2001) that assumes data were missing at random (MAR). The third was done using a pattern mixture modeling approach that assumes the data were not missing at random (NMAR) but conditional upon a pattern of missingness (Little, 1993). In this approach, subjects were divided into two data sets reflecting two patterns of missing data (low and high), and 10 imputations of each data set were created, merged together, and analyzed (Thijs et al., 2002). The MAR and NMAR analyses did not differ substantially, while the CMAR showed noticeably fewer statistically

Table 1. Demographic characteristics of participants.

Characteristic	*N*	%
Female	247	72
Raising children at home	125	37
School-aged children in home	62	19
Have a graduate degree	204	60
Employee taking classes	110	32
Non-White race	47	14
Received a flu shot	138	40
Missed work due to illness	64	19
30-day cold/flu illness	115	34
30-day GI illness	41	12
	Mean	SD
Age, years	43.20	12.64
Household income, US dollars	84,451	87,896
Estimated time spent working with public	54.57	29.75
Number of work days missed	0.39	1.00
Number of household wage earners	1.77	0.61

SD: standard deviation; GI: gastrointestinal.
For dichotomous characteristics, the percentage values are calculated from the total number of responses, which may be less than the total number of respondents due to missing data.

significant results due to smaller sample size. The MAR results are presented as they appear most appropriate.

Results

From a base of 5504 workers, 1600 email invitations were randomly generated. Of these, 28 were not operative and 19 had opted out of receiving any questionnaires from the university. Approximately 23 percent participated (n = 361/1553). Most participants were female (72%) and had completed graduate education (60%); of which, 14 percent self-identified as non-White. Over 1/3 reported raising children, and nearly 1/3 employed were taking classes. Greater than 1/3 reported symptoms of a cold or flu-like illness in the last 30 days, while 12 percent reported experiencing symptoms of a GI infection. When combined, 39 percent (141) self-identified as having one or both illnesses in the past 30 days; of those, 34 percent (41) were absent from work due to these conditions, with most employees missing no more than 1 day (Table 1). The top three beliefs about protective hand hygiene practices for which participants reported always or usually were as follows: after using a urinal or toilet (97.2%); before eating or handling food (79.2%); and after blowing their nose, coughing, or sneezing (60.6%).

All hypothesized theoretical constructs had factor loadings of 0.35 or greater in SEM. Control beliefs were separated into two distinct constructs that reflected environmental access and time. Results from CFA demonstrated statistically significant loadings greater than 0.40 for all items. All correlation coefficients for discriminant analysis were substantially below 0.80 (Table 2). The construct of hand hygiene behaviors contained the largest number of items that stayed in the model, losing only one item due to lack of variation from a nearly unanimous affirmative response (performing hand hygiene after using a urinal or toilet). A total of 96.8 percent of participants answered "always or usually" to the question "When I intend to clean my hands I actually follow through and do it." Thus, this question dealing with intention did not load in the model due to lack of variance.

SEM revealed that all hypothesized constructs were significantly associated with hand hygiene performance. Demographic analyses revealed significantly fewer hand hygiene behaviors practiced by those who completed graduate education and those who were younger. No differences were found in the prediction of hand hygiene behaviors by gender or raising children (Table 3).

Hand hygiene behaviors significantly reduced the odds of reporting sickness by 45 percent from the common cold/influenza-like illnesses and GI infections during the past 30 days, when combined. Those who self-identified as non-White had over twofold higher odds of experiencing these infections (Table 4).

Table 2. Confirmatory factor analysis of hypothesized hand hygiene constructs.

Construct/Item	Est.	SE	Construct correlations						Cronbach's alpha
			1	2	3	4a	4b	5	
1. Hand hygiene behavior			1.00						0.89
Before I eat or handle food	0.44	0.04							
After I handle money	0.86	0.05							
After coughing/sneezing/blowing nose	0.63	0.05							
After I use a shared keyboard/pad	0.97	0.05							
After I share pens	0.84	0.05							
After picking up something	0.79	0.06							
After shaking hands coughed/sneezed	0.65	0.05							
After touching public surfaces	0.89	0.05							
2. Behavioral beliefs			0.53	1.00					0.92
I can get sick if I don't	0.75	0.04							
Protecting the health of my family	0.70	0.03							
Protecting my health	0.66	0.03							
Protecting the health of my coworkers	0.71	0.03							
I can get sick if I rub my eyes/nose	0.57	0.04							
3. Normative beliefs			0.35	0.32	1.00				0.80
My employer expects me to	0.58	0.07							
My colleagues do	0.79	0.06							
Our customers do	0.48	0.04							
People I work with think it's important	0.95	0.07							
The clientele that I serve do	0.54	0.04							
4a. Control beliefs: access to hand sanitizer			0.43	0.40	0.38	1.00			0.74
It is convenient for me to use	0.74	0.05							
Hand sanitizer makes it easier	0.72	0.05							
I carry hand sanitizer with me	1.20	0.07							
I have hand sanitizer on my desk	1.25	0.07							
4b. Control beliefs: convenience of hand hygiene			0.21	0.23	0.16	0.13*	1.00		0.83
It is convenient for me to get to a sink	0.67	0.06							
I have sufficient time	0.67	0.05							
I do not perceive any barriers to hand hygiene at work	0.54	0.05							
5. Beliefs about protective hand hygiene practices			0.48	0.40	0.17	0.26	−0.01*	1.00	0.93
After using a shared keyboard/pad	0.71	0.03							
After sharing pens	0.91	0.04							
After picking up from floor	0.79	0.04							
After touching public surfaces	0.73	0.04							

SE: standard error; TLI: Tucker–Lewis index; RMSEA: root mean square error of approximation.
Model fit: TLI = 0.909; RMSEA = 0.06.
All factor loadings and construct correlations are significant ($p < 0.05$) except correlations marked with "*."

Table 3. Structural equation model of hypothesized hand hygiene motivators predicting hand hygiene behavior.

Regressor	Standardized coefficient	95% confidence interval
Modified theory of planned behavior constructs		
Behavioral beliefs	0.30	(0.18, 0.41)**
Normative beliefs	0.13	(0.02, 0.24)*
Control beliefs:		
Access to hand sanitizer	0.16	(0.04, 0.28)*
Convenience of hand hygiene	0.14	(0.03, 0.25)*
Beliefs about protective hand hygiene practices	0.31	(0.19, 0.42)**
Potential confounders		
Female	−0.13	(−0.37, 0.11)
Age	0.01	(0.00, 0.02)*
School-aged children in home	−0.07	(−0.32, 0.17)
Household income	0.00	(0.00, 0.00)
Have a graduate degree	−0.30	(−0.51, −0.09)*
Employee taking classes	0.05	(−0.19, 0.28)
Non-White race	0.02	(−0.28, 0.32)
Estimated time spent working with public	0.00	(0.00, 0.01)

TLI: Tucker–Lewis index; RMSEA: root mean square error of approximation.
Model fit: TLI = 0.88; RMSEA = 0.053; R^2 = 0.33.
$^*p < 0.05$, $^{**}p < 0.01$.

Table 4. Structural equation model predicting the odds of self-reported 30-day cold/influenza and/or GI infection.

Regressor	Odds ratio	95% confidence interval
Hand hygiene behavior	0.55	(0.30, 0.98)*
Received a flu shot	1.02	(0.62, 1.68)
Female	1.35	(0.80, 2.29)
Age	1.02	(0.99, 1.04)
School-aged children in home	1.20	(0.66, 2.19)
Household income	1.00	(0.99, 1.01)
Have a graduate degree	1.05	(0.62, 1.75)
Employee taking classes	0.91	(0.52, 1.59)
Non-White race	2.75	(1.26, 5.98)*
Estimated time spent working with public	1.00	(0.99, 1.01)

GI: gastrointestinal.
Model fit: log likelihood = −11942.993, Bayesian information criterion (BIC) = 24,804.
$^*p < 0.05$.

Discussion

The findings from this study, which employed a model drawn from key components of the TPB, revealed that all major constructs loaded in EFA; CFA demonstrated good convergent and discriminant validity, and Cronbach's alpha demonstrated acceptable internal reliability. SEM paths indicated that the constructs predicted self-reported hand hygiene behaviors, and hand hygiene behaviors reduced the odds of reporting sickness from respiratory tract illness or GI infection when the two variables were combined.

These findings are consistent with recommendations for utilization of multifaceted approaches to improve employee health through comprehensive worksite programs (National Institute for Occupational Safety and Health, 2008) and to create organizational cultures that promote patient safety through hand hygiene programs among healthcare professionals (Larson et al., 2000; Whitby et al., 2007).

The fact the latent constructs were associated with higher self-reported hand hygiene practices is congruent with findings from hand hygiene studies among health-care professionals and the public. Behavioral beliefs, normative beliefs, and control beliefs have been positively associated with 80 percent or more hand hygiene behavior adherence among health-care professionals (Sax et al., 2007). Messages consistent with social norms have effectively motivated improved hand hygiene behavior in both women and men at several highway rest-stops (Judah et al., 2009).

As previously noted, participants nearly unanimously self-reported that their "intention" to perform hand hygiene translated into behavior, and thus, this question did not load in the model due to lack of variance. This was anticipated. Compared to healthcare workers, on the whole, protective hand hygiene practices among university employees are less complex to carry out. Additionally, in this university environment, numerous restrooms with sinks are available in all buildings and hand sanitizer is available in many public areas. In light of this, as well as constraints on the length of the survey imposed by the university, intention was not measured as a complete construct containing three or more items, unlike the five major constructs included in the modified model. Instead, intention was assessed indirectly through self-reported hand hygiene behavior. A similar model was constructed by Sax et al. (2007) in their investigation of hand hygiene among health care professionals.

Pathogenic microorganisms can contaminate both porous and nonporous surfaces or objects that can serve as sources for hand transmission (Boone and Gerba, 2007). Given the relatively low hand hygiene performance after sharing pens (11%) and keyboards (27.1%); picking items up of the floor (29%); handling money (34.4%); and touching public surfaces, such as elevator buttons, door knobs, and stair handles (33.8%), along with relatively high self-reported infections, these findings show a need for hand hygiene improvement.

The 2011–2012 influenza season had the latest onset in nearly three decades (CDC, 2012), and these responses were captured during the peak flu season. Further research is needed to understand why non-White employees ($n = 47$) had 2.75 times greater odds of reporting infections compared to White employees.

Limitations and strengths

This study had several limitations. First, the survey utilized self-reported hand hygiene instead of observed hand hygiene. Self-report has overestimated hand hygiene performance among health-care workers and the general public (Harris Interactive, 2010; The Joint Commission, 2009). Second, self-report was used for both identification of symptoms within the past 30 days and associated absenteeism; neither lab nor physician diagnoses were utilized. While research has found under-reporting of lost days from monthly recall (Stewart et al., 2004), satisfactory accuracy and validity have been shown among the public in self-reporting symptoms of infectious disease that included acute respiratory tract infection (Orts et al., 1995). Further, symptoms identified in the survey were consistent with CDC definition for influenza (2011). Third, since this study was not a randomized national sample, the results cannot be generalized to all public universities.

Fourth, respondents in this random-sample survey represented only about one-quarter of employees; compared to all employees in the university, participants were more likely to be women (72% vs 38%) and White than non-White (86% vs 58%).

Results for potential confounders differed from those in previous research. Women have shown higher hand hygiene practices than men (Harris Interactive, 2010), and in one study, non-White college students had higher hand hygiene practices than Whites (Anderson et al., 2008). However, the findings from this study showed no difference in hand hygiene performance by gender or race. A high percentage of respondents self-identified as raising children (62.9%). Since children experience a higher average number of acute respiratory tract infections per year compared to adults, it was hypothesized that those raising children would have higher hand hygiene practices; however, no difference in hand hygiene behaviors was seen. A majority had completed graduate degrees, and those with graduate education self-reported lower hand hygiene behaviors than those without. Finally, hand hygiene decreased linearly with age. Qualitative research is needed to understand hand hygiene motivations among those with graduate degrees and those from a variety of ages.

Despite these limitations, the paths of the model functioned as hypothesized, and the overall fit of the model was good as demonstrated by a relatively high TLI, low RMSEA for CFA and SEM, and an R^2 of 0.33. These findings were similar to those found among bank employees in the Midwestern United States (Stedman-Smith et al., 2012). Although the replication of results in different populations strengthens the merit of the findings, caution is warranted in interpretation since both studies are based on self-report and lack temporality due to the use of cross-sectional surveys.

Conclusion

Community hand hygiene improvement interventions in day care centers, schools, and private homes have reduced infectious diseases. Few investigations among general worker populations related to usual hand hygiene performance and behavioral motivations or interventions to improve hand hygiene have been conducted. Employees often work closely together, share supplies, and have the potential to spread pathogens implicated in infectious disease. While the number of employees who contract communicable disease at work has not been well quantified, in one study, 45 percent of workers identified contracting influenza from coworkers, while only 16 percent reported contracting influenza from household members (Palmer et al., 2010).

These results underscore the importance of good hand hygiene and respiratory etiquette among employees and support the implementation of multi-component approaches in the workplace. The costs of communicable infections are in the billions of dollars annually (Fendrick et al., 2003; Molinari, et al., 2007). The US CDC (2013a) recommends hand hygiene as part of a three-tiered approach to promote the health of workers, and the WHO Writing Group (Bell et al., 2006) has recommended hand hygiene as a nonpharmaceutical approach to delay the spread of influenza until vaccines can be developed in pandemics; yet, only a few hand hygiene improvement intervention studies for office workers have been conducted.

These results support interventions utilizing a multi-modal approach including providing information about protective hand hygiene practices to break the spread of pathogens, discussing the positive outcomes of practicing hand hygiene behaviors, incorporating social expectations of coworkers and supervisors for clean hands, and implementing environmental changes to facilitate improved access to hand hygiene supplies. The most effective hand hygiene campaigns demonstrating sustained improvement among health-care professionals have utilized multi-pronged strategies (The Joint Commission, 2009; Wilson et al., 2011) that are consistent with this model. The findings meaningfully contribute to the development of hand hygiene improvement interventions for employees in public university settings and provide insight into the development of future intervention studies in office worksites.

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