Discover Public Health

RESEARCH Open Access

Factors predicting infection prevention and control practices and hand hygiene compliance among childcare workers

Chakkrich Pidjadee[1*], Kim Lam Soh[2*], Hasni Idayu Saidi[3] and Kim Geok Soh[4]

*Correspondence:
Chakkrich Pidjadee
chakkrich.pi@ssru.ac.th
Kim Lam Soh
sklam@upm.edu.my
[1]College of Nursing and Health, Suan Sunandha Rajabhat University, 75000 Samut Songkhram, Thailand
[2]Department of Nursing, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, UPM, 43400 Serdang, Selangor, Malaysia
[3]Department of Biomedical Sciences, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia
[4]Department of Sport Studies, Faculty of Educational Studies, Universiti Putra Malaysia, Serdang, Selangor, Malaysia

Abstract

Infection prevention and control (IPC), particularly hand hygiene (HH), is essential for reducing communicable diseases in daycare centers, where young children are highly vulnerable to infection transmission. This study aimed to identify factors predicting IPC practices and HH compliance among childcare workers in daycare centers in Bangkok, Thailand. A descriptive cross-sectional study was conducted among 180 childcare workers from 90 daycare centers selected using stratified random sampling. Validated questionnaires assessed IPC knowledge, attitudes, practices, self-efficacy, HH intention, and HH compliance. Data were analyzed using descriptive statistics, Spearman's correlation, multiple linear regression, and logistic regression. IPC attitudes and self-efficacy significantly predicted IPC practices, accounting for 20% of the variance ($R^2 = 0.200$, $F = 7.190$, $p < 0.001$). IPC attitudes ($\beta = 0.167$, $p = 0.020$) and IPC self-efficacy ($\beta = 0.387$, $p < 0.001$) were positively associated with IPC practices. Other examined variables, including HH intention and sociodemographic characteristics, did not significantly predict HH compliance. The HH compliance model demonstrated limited explanatory power ($R^2 = 0.011$, adjusted $R^2 = -0.012$, $p = 0.744$). These findings suggest that IPC attitudes and self-efficacy may play important roles in IPC practices among childcare workers, whereas knowledge alone was not significantly associated with practices. Interventions targeting IPC attitudes and self-efficacy may help strengthen IPC practices. Future studies should examine additional organizational and contextual factors that may influence IPC practices and HH compliance in daycare settings.

Keywords Childcare workers, Daycare center, Hand hygiene, Infection control, Infection prevention, Predictor

1 Introduction

Infection prevention and control (IPC) is an evidence-based approach to preventing the transmission of infectious agents and protecting individuals and communities. Key IPC measures, including hand hygiene (HH), personal protective equipment (PPE) use, environmental cleaning, and waste management, are collectively known as standard

© The Author(s) 2026. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by-nc-nd/4.0/.

precautions [1]. Among these, HH is widely recognized as the most effective and fundamental strategy for preventing infection transmission in healthcare and childcare settings [2].

Daycare centers, where children under five spend approximately 15–35 h per week [3], are high-risk environments for infectious disease transmission. Children's immature immune systems, close contact, shared materials, and dependence on staff for hygiene increase their vulnerability [4]. Poor environmental sanitation has also been associated with a higher risk of stunting among children under five [5]. Studies consistently report higher rates of gastrointestinal and respiratory infections in daycare settings than in home-based care [6]. In Thailand, common illnesses include respiratory infections, influenza, hand-foot-and-mouth disease (HFMD), respiratory syncytial virus (RSV), and COVID-19 [7]. In 2025, Bangkok ranked among the ten provinces with the highest influenza and HFMD incidence, with most HFMD cases occurring among children under four years of age and 80% of outbreak clusters reported in daycare centers [8, 9]. Effective IPC measures can substantially reduce absenteeism and communicable disease transmission in these settings [10].

Within this context, childcare workers play a central role in implementing IPC measures [4]. Proper HH can reduce diarrheal diseases by approximately 30% in daycare settings [11], while regular toy cleaning reduces microbial contamination [12]. Despite established guidelines [4], IPC implementation remains inconsistent. In Thailand, studies indicate that many childcare workers have inadequate knowledge, less favorable attitudes, and suboptimal IPC practices [13]. Specifically in Bangkok, although communicable disease prevention behaviors were generally reported as good [14], some childcare workers did not meet recommended handwashing duration and thoroughness standards [15, 16]. These findings underscore the continued public health importance of strengthening IPC implementation in daycare settings.

To explain these behavioral variations, this study draws on the Knowledge–Attitude–Practice (KAP) model, the Theory of Planned Behavior (TPB) [17], and Social Cognitive Theory (SCT) [18]. These frameworks suggest that cognitive (knowledge), affective (attitudes), and psychological factors (self-efficacy and intention) interact to shape preventive behaviors. The KAP model proposes that knowledge influences attitudes, which in turn promote appropriate practices [19]. Previous studies have linked IPC knowledge and attitudes with better IPC practices among childcare workers, although findings remain inconsistent [13, 20–22]. SCT further emphasizes self-efficacy as a key determinant of sustained behavioral performance [18], and higher IPC self-efficacy has been associated with improved IPC practices among childcare workers [20].

Sociodemographic factors may also influence IPC practices, although evidence regarding age, education, and work experience is mixed [14, 21, 22]. Training experience, however, has been more consistently associated with improved IPC practices [21, 22]. For HH compliance, the TPB identifies behavioral intention as the most immediate predictor of behavior [17]. Stronger HH intention has been associated with better self-reported HH compliance [23]. Evidence on sociodemographic influences remains limited and inconsistent: age predicted self-reported but not observed HH compliance, whereas work experience showed no association [23]. The number of children in care has also been linked to HH compliance [24]. Although childcare-specific evidence is limited, studies among healthcare workers suggest that HH training is associated with better

compliance [25]. These gaps highlight the need to further investigate determinants of HH compliance among childcare workers.

Although closely related, IPC practices and HH compliance represent distinct behavioral constructs. IPC practices encompass broader preventive activities, such as PPE use, environmental cleaning, food safety, and waste management [1], whereas HH compliance reflects a specific, routine hygiene behavior influenced by situational and environmental factors [26]. Therefore, HH compliance was examined separately to better capture its unique determinants.

Despite growing international evidence, limited research has simultaneously examined the multidimensional determinants of IPC practices and HH compliance among childcare workers in Thailand, particularly within urban daycare settings such as Bangkok. Understanding how cognitive, psychological, and sociodemographic factors contribute to these outcomes is essential for designing effective, context-specific interventions. Therefore, this study aims to examine how sociodemographic characteristics, IPC knowledge, attitudes, and self-efficacy predict IPC practices, as well as how sociodemographic variables and HH intention predict HH compliance among childcare workers in daycare centers.

2 Materials and methods

2.1 Study design

This study employed a descriptive cross-sectional design and was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [27].

2.2 Sample and setting

A total of 180 childcare workers from 90 daycare centers in Bangkok were recruited using a stratified random sampling strategy based on daycare size (small, medium, large) to ensure proportional representation across different center sizes and to control for potential confounding by size [23].

In 2024, Bangkok had 278 registered daycare centers, categorized as small (n = 166), medium (n = 59), and large (n = 53) [28]. A sampling frame of eligible centers was created for each stratum using the official registry. Daycare centers were randomly selected within each stratum using a computer-generated random number procedure, proportional to the distribution of centers by size. Accordingly, 90 centers were selected, including 54 small centers, 19 medium centers, and 17 large centers. If a selected center declined participation, a replacement center from the same stratum was randomly selected using the same procedure. From each participating center, two childcare workers were recruited using simple random selection from the list of eligible workers provided by the center administrator. If a center had only two eligible workers, both were invited to participate.

Inclusion criteria were: (1) registered daycare centers in Bangkok with at least two childcare workers, (2) childcare workers aged 18 years or older who had been employed for at least three months, (3) responsible for the care of children under five years of age, and (4) able to read and speak Thai.

Because participants were recruited from daycare centers, the data had a potentially clustered structure, with childcare workers nested within centers. However, the study

employed stratified random sampling by daycare center size rather than formal cluster sampling. Intra-cluster correlation (ICC) and design effects were not incorporated into the sample size calculation or statistical analyses. To help reduce potential clustering effects, only two childcare workers per center were recruited. This issue is acknowledged as a methodological limitation.

2.3 Sample size

The sample size was determined based on the primary outcome of IPC practices, which was analyzed using multiple linear regression. Following the recommendation of Tabachnick and Fidell (2019) for testing individual predictors in multiple regression, the minimum sample size was estimated using the formula $N > 50 + 8$ m, where m represents the number of predictor variables [29]. With six predictors included in the regression model (sociodemographic characteristics, IPC knowledge, attitudes, and self-efficacy), the minimum required sample size was 98 participants.

To strengthen the justification for the sample size, an a priori power analysis for multiple linear regression (fixed model, R^2 deviation from zero) was conducted using G*Power version 3.1. Assuming a medium-to-large effect size (Cohen's $f^2 = 0.21$), derived from a previous study examining predictive factors of communicable disease prevention and control behaviors among childcare workers in Bangkok daycare centers [14], with a significance level (α) of 0.05, statistical power ($1 - \beta$) of 0.80, and six predictor variables, the minimum required sample size was 72 participants. Therefore, the final sample of 180 childcare workers exceeded the minimum requirement for multiple regression analysis.

2.4 Research instruments

Validated questionnaires were used to assess study variables, with permission obtained for use and adaptation where required. Instruments were reviewed and modified based on the literature and updated IPC guidelines to ensure relevance to childcare settings [1, 4, 30]. Original English instruments were translated into Thai using a forward–backward translation process [31]. Psychometric evaluation included expert review for content validity (nine experts), face validity assessment with childcare workers ($n = 10$), and internal consistency testing in both a pilot study ($n = 40$) and the main study ($n = 180$).

2.4.1 Demographic questionnaire

A demographic questionnaire developed by the principal investigator (PI) collected information on gender, age, education level, years of work experience in childcare, number of children in care, and prior experience with IPC training.

2.4.2 IPC knowledge, attitudes, and practices questionnaires

The IPC knowledge, attitudes, and practices questionnaires were adapted from instruments developed by Thongchai and colleagues [22] for Thai childcare workers and aligned with the *Disease-Free Childcare Centers Policy* issued by the Department of Disease Control, Ministry of Public Health, Thailand (2015). Based on updated IPC recommendations, the instruments were revised to include vaccination monitoring, PPE use, food handling, waste management, and HH. The final versions consisted of 20 knowledge items (dichotomous scoring), 15 attitude items (5-point Likert scale), and 20 practice items (5-point Likert scale). Higher scores indicated greater IPC knowledge, more

positive attitudes, and better IPC practices, respectively. Content validity was satisfactory to excellent (S-CVI/Ave = 0.96, 0.98, and 0.98, respectively). Internal consistency was acceptable in both the pilot study (Cronbach's alpha = 0.76, 0.74, and 0.87, respectively) and the main study (Cronbach's alpha = 0.73, 0.75, and 0.74, respectively).

2.4.3 IPC self-efficacy questionnaire

IPC self-efficacy was assessed using an adapted version of the questionnaire developed by Joo and Kim [20]. The Thai-adapted instrument retained 15 items rated on a 5-point Likert scale, covering confidence in performing IPC-related tasks, including PPE use, cleaning and disinfection, food handling, waste management, HH, and management of sick children. Higher scores indicated stronger IPC self-efficacy. The instrument demonstrated excellent content validity (S-CVI/Ave = 0.99) and high internal consistency in both the pilot study (Cronbach's alpha = 0.94) and the main study (Cronbach's alpha = 0.90).

2.4.4 HH intention and compliance questionnaires

HH intention and HH compliance were measured using adapted instruments developed by Zomer and colleagues [23]. The HH intention questionnaire consisted of two items rated on a seven-point Likert scale, whereas the HH compliance questionnaire included 15 items rated on an 11-point scale assessing HH behaviors in guideline-recommended situations. Higher scores indicated stronger HH intention and better HH compliance. The adapted Thai versions demonstrated acceptable to excellent content validity (S-CVI/Ave = 0.78 for HH intention and 0.99 for HH compliance) and acceptable internal consistency in both the pilot study (Cronbach's alpha = 0.83 for HH intention and 0.85 for HH compliance) and the main study (Cronbach's alpha = 0.76 for HH intention and 0.76 for HH compliance).

2.5 Data collection

After obtaining approval from the Institutional Review Board (IRB), data were collected between March and April 2025. Questionnaires were distributed to participants via daycare center managers and were completed through an online survey platform. Prior to participation, all respondents were presented with an electronic informed consent form explaining the study purpose, procedures, potential risks and benefits, confidentiality, and voluntary participation. Participants indicated their consent electronically by selecting "I agree to participate" before proceeding to the survey. Those who declined consent could exit the survey before proceeding to the questions. The PI managed all data entry and quality control.

2.6 Data analysis

Data were analyzed using IBM SPSS Statistics (version 29.0.1.0 for macOS). Descriptive statistics summarized demographic characteristics and study variables. The Kolmogorov–Smirnov test was used to assess the normality of continuous variables, including age, years of work experience in childcare, number of children in care, IPC knowledge, IPC attitudes, IPC practices, IPC self-efficacy, HH intention, and HH compliance. Spearman's correlation examined relationships among study variables. Multiple linear regression analysis (enter method) was conducted to assess the predictive effects

of continuous factors on IPC practices and HH compliance among childcare workers. A p-value < 0.05 was considered statistically significant.

Assumptions of multiple linear regression were evaluated. Although some variables were non-normally distributed, residual scatterplots confirmed that the assumptions of normality, linearity, and homoscedasticity were met. Multicollinearity was assessed using variance inflation factor (VIF) values, all of which were below 10, indicating no multicollinearity concerns.

Additionally, IPC practice and HH compliance scores were categorized using a 50% cut-off, following a previous study examining IPC and preventive behaviors among childcare workers [21]. IPC practice scores > 50 were classified as good and ≤ 50 as poor, while HH compliance scores > 75 were classified as good and ≤ 75 as poor. A Pearson's chi-square test of contingencies and bivariate logistic regression was then conducted to examine associations between categorical predictor variables (education level and training experience) and IPC practices and HH compliance. Associations were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). ORs greater than 1 indicated higher odds of being classified in the good IPC or HH compliance category, whereas ORs less than 1 indicated lower odds. A p-value < 0.05 was also considered statistically significant.

3 Results

3.1 Demographic characteristics of participants

All 180 questionnaires were completed, yielding a 100% response rate. Most participants were women (97.2%), with a mean age of 41.38 years ($SD = 10.99$). Half held at least a bachelor's degree and had an average of 10.14 years of work experience ($SD = 8.98$). On average, participants cared for 16.24 children per day ($SD = 9.64$), and 68.9% had previously attended an IPC training session. As shown in Table 1, all study variables had mean scores above 50% of the maximum possible scores. The mean scores for IPC knowledge, attitudes, practices, and self-efficacy were 13.94 ($SD = 2.92$), 64.99 ($SD = 5.61$), 85.93 ($SD = 6.76$), and 62.16 ($SD = 7.20$), respectively. The mean scores for HH intention and HH compliance were 9.56 ($SD = 2.11$) and 127.38 ($SD = 11.23$), respectively.

3.2 Correlations between study variables

Table 2 presents the correlation matrix for continuous variables, whereas Table 4 summarizes associations among categorical variables. IPC attitudes showed a weak positive correlation with IPC practices ($r_s = 0.185$, $p = 0.013$), while IPC self-efficacy demonstrated a moderate positive correlation with IPC practices ($r_s = 0.332$, $p < 0.001$). In contrast, IPC knowledge ($r_s = 0.127$, $p = 0.089$), age ($r_s = 0.101$, $p = 0.177$), education level ($\chi^2 = 1.189$, $p = 0.276$), years of work experience ($r_s = 0.110$, $p = 0.142$), number of children in

Table 1 Study variables scores ($N = 180$)

Variables	Possible score	Actual score	Mean	SD
IPC knowledge	0–20	5–19	13.94	2.92
IPC attitudes	15–75	45–75	64.99	5.61
IPC practices	20–100	62–100	85.93	6.76
IPC self-efficacy	15–75	41–75	62.16	7.20
HH intention	2–14	4–14	9.56	2.11
HH compliance	0–150	100–148	127.38	11.23

IPC: infection prevention and control, HH: hand hygiene

Table 2 Spearman's rank correlation coefficients between study variables ($N = 180$)

Variables	Age	Work experience	Children in care	IPC knowledge	IPC attitudes	IPC self-efficacy	HH intention	IPC practices	HH compliance
Age	1								
Work experience	0.553 **	1							
Children in care	0.160 *	0.250 **	1						
IPC knowledge	0.180 *	0.206 **	0.136	1					
IPC attitudes	0.018	0.093	0.031	0.125	1				
IPC self-efficacy	0.062	0.086	-0.012	-0.015	0.391 **	1			
HH intention	0.026	0.016	0.077	-0.016	0.055	0.050	1		
IPC practices	0.101	0.110	0.068	0.127	0.185 *	0.332 **	-0.046	1	
HH compliance	0.036	0.058	0.102	0.126	0.077	0.140	-0.003	0.199 **	1

work experience = years of work experience, children in care = number of children in care, IPC: infection prevention and control, HH: hand hygiene, * = $p < 0.05$, ** = $p < 0.01$

Table 3 Pearson's chi-square test of contingencies and bivariate logistic regression analysis of categorical variables predicting infection prevention and control practices and hand hygiene compliance ($N = 180$)

Variables	Poor score, *n* (%)	Good score, *n* (%)	Total, *n* (%)	χ^2 (df)	OR [95% CI]	*p*-value
IPC practices						
Education level				1.189 (1)		
Less than bachelor degree (reference)	7 (33.3)	73 (45.9)	80 (44.4)		1.00	-
Bachelor degree and above	14 (66.7)	86 (54.1)	100 (55.6)		0.572 [0.217, 1.511]	0.260
Training experience				0.055 (1)		
Never (reference)	7 (33.3)	49 (30.8)	56 (31.1)		1.00	-
Ever	14 (66.7)	110 (69.2)	124 (68.9)		1.225 [0.458, 3.274]	0.686
HH compliance						
Education level				0.706 (1)		
Less than bachelor degree (reference)	10 (37.0)	70 (45.8)	80 (44.4)		1.00	-
Bachelor degree and above	17 (63.0)	83 (54.2)	100 (55.6)		0.680 [0.289, 1.596]	0.375
Training experience				0.073 (1)	1.00	-
Never (reference)	9 (33.3)	47 (30.7)	56 (31.1)			
Ever	18 (66.7)	106 (69.3)	124 (68.9)		1.199 [0.496, 2.899]	0.687

IPC: infection prevention and control; HH: hand hygiene; OR: odds ratio; CI: confidence interval; reference categories for logistic regression were "less than bachelor's degree" for education level and "never" for training experience

Table 4 Multiple regression analysis with enter method of continuous variables predicting infection prevention and control practices and hand hygiene compliance ($N = 180$)

Variables	b	SE_b	Beta	t	*p*-value
IPC practices					
(Constant)	54.812	6.278		8.731	< 0.001
Age	-0.026	0.051	-0.042	-0.507	0.613
Years of work experience	0.040	0.063	0.053	0.642	0.522
Number of children in care	0.036	0.049	0.051	0.727	0.468
IPC knowledge	0.049	0.088	0.041	0.560	0.576
IPC attitudes	0.387	0.165	0.167	2.351	0.020
IPC self-efficacy	0.363	0.068	0.387	5.315	< 0.001
$R = 0.447$; $R^2 = 0.200$; $R_a^2 = 0.172$; $SE_b = 6.154$; Overall $F = 7.190$; $p < 0.001$					
HH compliance					
(Constant)	123.064	5.104		24.113	< 0.001
Age	0.028	0.092	0.027	0.300	0.764
Years of work experience	0.043	0.094	0.034	0.456	0.649
Number of children in care	0.107	0.089	0.092	1.200	0.232
HH intention	0.149	0.400	0.028	0.372	0.710
$R = 0.105$; $R^2 = 0.011$; $R_a^2 = -0.012$; $SE_b = 11.299$; Overall $F = 0.488$; $p = 0.744$					

IPC: infection prevention and control, HH: hand hygiene, b = unstandardized coefficient, SE_b: standard error for the unstandardized coefficient, t: t-test statistic, R^2: proportion of variance in the dependent variable explained by the independent variable

care (r_s = 0.068, $p = 0.366$), and training experience (χ^2 = 0.055, $p = 0.815$) were not significantly associated with IPC practices.

Regarding HH compliance, IPC practices showed a weak but statistically significant positive correlation with HH compliance (r_s = 0.199, $p < 0.01$). However, HH intention was not significantly associated with HH compliance (r_s = -0.003, $p = 0.964$). Similarly, age (r_s = 0.036, $p = 0.635$), education level (χ^2 = 0.706 $p = 0.401$), years of work experience (r_s = 0.058, $p = 0.441$), and number of children in care (r_s = 0.102, $p = 0.172$), and training experience (χ^2 = 0.073, $p = 0.787$) did not demonstrate significant associations with HH compliance.

3.3 Predictors of IPC practices and HH compliance

Table 3 presents the results of the multiple linear regression analyses using the enter method for continuous variables. For IPC practices, the overall model was statistically significant and explained 20.0% of the variance (R^2 = 0.200, adjusted R^2 = 0.154, $F = 7.190$, $p < 0.001$). IPC attitudes and IPC self-efficacy were significant positive predictors of IPC practices. Specifically, higher IPC attitudes were associated with higher IPC practice scores ($\beta = 0.167$, $p = 0.020$), whereas IPC self-efficacy showed the strongest association with IPC practices ($\beta = 0.387$, $p < 0.001$).

In contrast, the HH compliance model was not statistically significant (R^2 = 0.011, adjusted R^2 = −0.012, $F = 0.488$, $p = 0.744$). None of the examined variables significantly predicted HH compliance. Although the regression coefficients suggested mixed directions of association, age ($\beta = 0.027$, $p = 0.764$), years of work experience ($\beta = 0.034$, $p = 0.649$), number of children in care ($\beta = 0.092$, $p = 0.232$), and HH intention ($\beta = 0.028$, $p = 0.710$) were not statistically significant predictors.

Table 4 presents the results of the Pearson's chi-square tests and bivariate logistic regression analyses for categorical variables. In the logistic regression analyses, "less than bachelor's degree" was used as the reference category for education level, and "never" was used as the reference category for training experience. For IPC practices,

neither education level (OR = 0.572, 95% CI = 0.217–1.511, $p = 0.260$) nor training experience (OR = 1.225, 95% CI = 0.458–3.274, $p = 0.686$) significantly predicted IPC practices. Similarly, for HH compliance, neither education level (OR = 0.680, 95% CI = 0.289–1.596, $p = 0.375$) nor training experience (OR = 1.199, 95% CI = 0.496–2.899, $p = 0.687$) showed significant associations.

4 Discussion

This study examined predictors of IPC practices and HH compliance among childcare workers in daycare centers. IPC attitudes and self-efficacy significantly predicted IPC practices, whereas none of the examined variables predicted HH compliance. These findings suggest that cognitive and psychological factors contributed to broader IPC practices but did not meaningfully explain HH compliance in this sample.

Consistent with the study framework, IPC attitudes significantly predicted IPC practices. Childcare workers with more positive attitudes toward infection prevention reported better IPC practices. This finding aligns with previous studies among childcare workers showing that favorable attitudes are associated with stronger preventive behaviors [13, 22]. Similarly, IPC self-efficacy emerged as the strongest predictor of IPC practices, indicating that childcare workers who felt more capable of implementing IPC measures were more likely to report better practices. This finding is consistent with prior research linking stronger self-efficacy with improved infection prevention behaviors among childcare personnel [20]. Together, these findings suggest that strengthening positive attitudes and perceived capability may support improvements in IPC practices.

In contrast, IPC knowledge was not significantly associated with IPC practices. Although this differs from studies reporting positive knowledge–practice relationships [20–22, 32], it aligns with Thai research showing that knowledge alone did not predict communicable disease prevention behaviors among childcare workers [13]. Knowledge is essential for awareness and skill-building but must be consistently reinforced and embedded into daily routines to sustain practice [33]. In the present study, factual knowledge may have been insufficient to explain behavioral variation without corresponding motivational or confidence-related factors, as reflected by the stronger effects of attitudes and self-efficacy [34].

None of the sociodemographic variables—including age, education level, work experience, number of children in care, and training experience—predicted IPC practices or HH compliance. Overall, these findings suggest that demographic characteristics alone contributed little to explaining behavioral differences among participants. The absence of significant training effects may indicate that previous IPC training, as measured in this study, varied in content, duration, or recency and therefore did not translate into measurable behavioral differences [35].

Age was not associated with either outcome, consistent with some studies [13, 14, 36] but differing from findings among Thai and Dutch childcare workers [22, 23]. Education level likewise showed no association, aligning with previous studies [13, 22], suggesting that formal education alone may not translate into IPC-related behavioral performance [37]. Years of work experience also did not predict either outcome, consistent with prior childcare research [13, 14, 23], indicating that accumulated experience alone may be insufficient to improve preventive behaviors [13]. The number of children in care showed no association with either outcome, aligning with studies from Iraq and

Egypt but contrasting with findings among Dutch childcare workers [23, 38, 39]. Finally, IPC training experience did not predict IPC practices or HH compliance, consistent with childcare studies [13, 14] but differing from healthcare research linking training to improved HH compliance [25]. Collectively, these findings suggest that individual demographic and training characteristics alone contributed little to explaining IPC practices and HH compliance.

HH intention was also not significantly associated with HH compliance. This finding contrasts with previous childcare research showing positive associations between intention and self-reported HH compliance [23]. Importantly, the HH compliance model demonstrated very low explanatory power ($R^2 = 0.011$; adjusted $R^2 = -0.012$), indicating that the included predictors explained virtually none of the variability in HH compliance. The negative adjusted R^2 further suggests that the model performed no better than a model without predictors after accounting for model complexity [40]. Therefore, the non-significant findings should be interpreted cautiously and may reflect limitations in the explanatory relevance of the selected variables for HH behavior in this setting.

One possible explanation is that HH compliance, as a highly routine and context-dependent behavior, may be influenced by factors not measured in this study. Situational influences—such as workflow demands, supervision, availability of hand hygiene resources, organizational expectations, or environmental prompts—may be more important determinants of HH compliance than individual intention or demographic characteristics [41, 42]. This interpretation remains inferential, as these factors were not directly assessed in the present study.

A further consideration is the potential for a ceiling effect in HH compliance scores. Participants generally reported relatively high HH compliance with limited score variability, which may have reduced the ability of the regression model to detect significant predictors [43]. Because HH compliance was assessed using self-reported measures, social desirability bias may also have contributed to inflated scores and restricted variability [44]. These measurement characteristics may partly explain the weak model fit and non-significant findings.

Overall, the model accounted for 20% of the variance in IPC practices but did not significantly explain HH compliance. The HH compliance model demonstrated very poor fit, indicating that the examined predictors contributed little to explaining variability in HH compliance beyond chance. This finding suggests that HH compliance may be influenced by additional factors not captured in the present study. Possible influences may include contextual, organizational, and behavioral factors—such as supervision practices, leadership support, institutional norms, workload, and facility conditions—which warrant further investigation. Future studies using implementation science or multilevel frameworks may help identify and examine these broader determinants of HH compliance among childcare workers.

This study has several limitations that should be acknowledged. First, its cross-sectional design precludes causal inference; therefore, observed associations between IPC practices and HH compliance cannot be interpreted as causal relationships. Second, data were collected using self-reported questionnaires, which may be subject to social desirability and recall bias. Although validated instruments were used, reported practices may not fully reflect actual behaviors. Third, the study was conducted among daycare centers in Bangkok, which may limit the generalizability of the findings to other regions

of Thailand or different childcare settings, such as municipally managed centers. Fourth, because participants were nested within daycare centers, unmeasured intra-cluster correlation may have influenced the estimates. ICC and design effects were not examined, which may affect the precision of the estimates and the generalizability of the findings. Finally, the model explained only a modest proportion of the variance in IPC practices and HH compliance, suggesting that additional contextual or organizational factors—such as supervision, workload, social norms, or infrastructure—may play important roles and should be explored in future research.

5 Conclusions

This study found that IPC attitudes and self-efficacy significantly predicted IPC practices among childcare workers, whereas no significant predictors of HH compliance were identified. The IPC practices model explained a modest proportion of variance, while the HH compliance model showed very low explanatory power, suggesting that the examined variables contributed little to explaining HH compliance. These findings suggest that strengthening IPC attitudes and self-efficacy may help improve IPC practices. In contrast, HH compliance may be influenced by additional factors not examined in this study. Overall, this study contributes evidence on the distinct determinants of IPC practices and HH compliance among childcare workers in daycare centers. Future studies should examine additional organizational and contextual factors using longitudinal or multilevel approaches.

Acknowledgements
The authors would like to express their sincere gratitude to the expert panel for their valuable input in the questionnaire revision process. We also extend our appreciation to the Foundation for Slum Child Care, Thailand, for their support in participant recruitment and data collection. Special thanks are given to all the childcare workers who generously contributed their time and participation to this study. In addition, the authors used AI-assisted language tools solely for language editing and grammatical refinement. All scientific content, interpretations, and final manuscript revisions were reviewed and approved by the authors.

Author contributions
All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Chakkrich Pidjadee, Kim Lam Soh, and Hasni Idayu Saidi. The first draft of the manuscript was written by Chakkrich Pidjadee and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding
This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data availability
The data supporting this study can be obtained from the corresponding author upon a reasonable request.

Declarations

Ethics approval and consent to participate
Ethical approval for this study was obtained from the Suan Sunandha Rajabhat University Ethics Committee, Thailand (Protocol Identification Number: COA.1–051/2024). All study procedures were conducted in accordance with the ethical standards of the institutional research committee and the principles of the World Medical Association's Declaration of Helsinki [45]. Participation in this study was voluntary and anonymous. Participants were informed that they could withdraw from the study at any time without consequence. Confidentiality was maintained through the use of unique identification codes in place of names. Electronic informed consent was obtained from all participants prior to their inclusion in the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 21 March 2026 / Accepted: 20 June 2026
Published online: 26 June 2026

References

1. World Health Organization. Infection prevention and control pre-service education and training curriculum: foundational content for all health and care workers. Geneva: World Health Organization. 2025. https://iris.who.int/bitstream/handle/10665/381225/9789240109964-eng.pdf?sequence=1. Accessed 19 Sep 2025.
2. U.S. Centers for Disease Control and Prevention. 2024. Clinical Safety: Hand Hygiene for Healthcare Workers. 2024. https://www.cdc.gov/clean-hands/hcp/clinical-safety/index.html. Accessed 22 Jul 2025.
3. Rey-Guerra C, Zachrisson HD, Dearing E, Berry D, Kuger S, Burchinal MR, et al. Do more hours in center-based care cause more externalizing problems? A cross-national replication study. Child Dev. 2023;94(2):458–77. https://doi.org/10.1111/cdev.13871.
4. Shope TR, Hashikawa AN. In: Shope TR, Hashikawa AN, editors. Managing Infectious Diseases in Child Care and Schools. 6 ed. Itasca, IL: American Academy of Pediatrics; 2023. https://doi.org/10.1542/9781610026604.
5. Ainy FN, Susanto T, Susumaningrum LA. The relationship between environmental sanitation of family and stunting among underfive children: A cross-sectional study in the public health center of Jember, Indonesia. Nurs Pract Today. 2021;8(3):173–8. https://doi.org/10.18502/npt.v8i3.5932.
6. Limtrakul D, Ongprasert K, Ayood P, Sapbamrer R, Siviroj P. A comparison of child development, growth and illness in home-care and day-care center settings. J Health Res. 2020;34(6):523–34. https://doi.org/10.1108/JHR-08-2019-0193.
7. Ministry of Public Health Thailand. The Situation of Five Major Infectious Diseases in Children in 2023. Nonthaburi. 2024. https://ddc.moph.go.th/uploads/files/414872024031203520 7.pdf. Accessed 2 Nov 2024.
8. Ministry of Public Health Thailand. Hand, Foot, and Mouth Disease Situation Report . Nonthaburi, 2025. https://utoapp.moph.go.th/e_doc/views/uploads/68c28390f175e-63681e35a0483834c030375d47b52cf2-1739.pdf. Accessed 19 May 2026.
9. Ministry of Public Health Thailand. Influenza, Situation Report T. 2025 Weekly Report No. 44 (26 October – 1 November 2025). Nonthaburi; 2025. https://ddc.moph.go.th/uploads/ckeditor2//files/DOE_flu_44.2568.pdf. Accessed 19 May 2026.
10. Willmott M, Nicholson A, Busse H, MacArthur GJ, Brookes S, Campbell R. Effectiveness of hand hygiene interventions in reducing illness absence among children in educational settings: a systematic review and meta-analysis. Arch Dis Child. 2016;101(1):42–50. https://doi.org/10.1136/archdischild-2015-308875.
11. Ejemot-Nwadiaro RI, Ehiri JE, Arikpo D, Meremikwu MM, Critchley JA. Hand-washing promotion for preventing diarrhoea. Cochrane Database Syst Rev. 2021;12(1):CD004265. https://doi.org/10.1002/14651858.CD004265.
12. Ibfelt T, Engelund EH, Schultz AC, Andersen LP. Effect of cleaning and disinfection of toys on infectious diseases and microorganisms in daycare nurseries. J Hosp Infect. 2015;89(2):109–15. https://doi.org/10.1016/j.jhin.2014.10.007.
13. Charoensiwarak K, Kitreerawutiwong N. Prevention and control practices of hand, foot, and mouth disease and related factors among teachers and child caregivers in childcare centres in Phitsanulok Province: a cross-sectional study. BMC Public Health. 2025;25(1):1236. https://doi.org/10.1186/s12889-025-22351-w.
14. Chanponga S, Nakakasien P, Krinuwat K. Predicting factors of preventive and control behaviorsof communicable diseases in children among teachers inchild care centers, Bangkok Metropolitan Administration. Chulalongkorn Med J. 2020;64(4):417–24. https://doi.org/10.58837/CHULA.CMJ.64.4.9.
15. Charoenchokpanit R, Pumpaibool T. Knowledge attitude and preventive behaviors towards hand foot and mouth disease among caregivers of children under five years old in Bangkok, Thailand. J Health Res. 2013;27:281–6.
16. Issarasongkhram M, Boonprakong T, Chunkao K. Hand washing behavior of child caregivers in the preschool child development center at Bangkok. KKU Res J (Graduate Studies). 2017;17(2):9–18.
17. Ajzen I. The theory of planned behavior. Organ Behav Hum Decis Process. 1991;50(2):179–211. https://doi.org/10.1016/0749-5978(91)90020-T.
18. Bandura A. Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice Hall.; 1986.
19. World Health Organization. Knowledge, attitudes, and practices (KAP) surveys during cholera vaccination campaigns: Guidance for Oral Cholera Vaccine Stockpile Campaigns. 2014. https://www.who.int/publications/m/item/knowledge-attitudes-and-practices-(kap)-surveys-during-cholera-vaccination-campaigns-guidance-for-oral-cholera-vaccine-stockpile-campaigns. Accessed 21 Jul 2025.
20. Joo A, Kim Y. Correlation of Childcare Teachers' Knowledge of Infectious Diseases, Health Locus of Control, Self-Efficacy, and Practice of Disease Prevention during the COVID-19 Pandemic. Korean J Childcare Educ. 2023;19(3):1–17. https://doi.org/10.14698/jkcce.2023.19.03.001.
21. Singh MK, Maurya M, Yoosuf AS, Nargotra S, Pawar PJ, Mukherjee R, et al. An Appraisal of Knowledge, Attitude and Practices of Anganwadi Workers under Integrated Child Development Services Scheme on Infection Prevention and Control in the Initial Months of COVID-19 Pandemic in District Lucknow, UP, India. J Med Evid. 2022;3(3):224–30. https://doi.org/10.4103/JME.JME_34_22.
22. Thongchai C, Promasatayaprot V, Woravong C, Srimuang P. Predictors of the Prevention of Practice Related to Communicable Disease Preventions of Child Caregivers in Child Development Centers, Ubon Ratchathani Province, Thailand. J Southwest Jiaotong Univ. 2021;56(6):379–88. https://doi.org/10.35741/issn.0258-2724.56.6.32.
23. Zomer TP, Erasmus V, van Empelen P, Looman C, van Beeck EF, Tjon-A-Tsien A, et al. Sociocognitive determinants of observed and self-reported compliance to hand hygiene guidelines in child day care centers. Am J Infect Control. 2013;41(10):862–7. https://doi.org/10.1016/j.ajic.2012.11.023.
24. Zomer TP, Erasmus V, van Beeck EF, Tjon-A-Tsien A, Richardus JH, Voeten HACM. Hand hygiene compliance and environmental determinants in child day care centers: An observational study. Am J Infect Control. 2013;41(6):497–502. https://doi.org/10.1016/j.ajic.2012.06.005.
25. Al-Qahtani AM. Clean hands, safe care: how knowledge, attitude, and practice impact hand hygiene among nurses in Najran, Saudi Arabia. Front Public Health. 2023;11:1158678. https://doi.org/10.3389/fpubh.2023.1158678.
26. World Health Organization. WHO Guidelines on Hand Hygiene in Health Care. Geneva, Switzerland: WHO Press. 2009. https://apps.who.int/iris/rest/bitstreams/52455/retrieve. Accessed 19 May 2026.
27. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. J Clin Epidemiol. 2008;61(4):344–9. https://doi.org/10.1016/j.jclinepi.2007.11.008.
28. Bangkok Department of Social Development. 2024. Total number of daycare centres by district. Bangkok, Report. Accessed 19 May 2026. https://commu.bangkok.go.th/stat/
29. Tabachnick BG, Fidell LS. Using Multivariate Statistics. 7th ed. Boston, MA: Pearson Education, Inc.; 2019.

30. Pidjadee C, Soh KL, Attharos T, Soh KG. The effect of infection prevention and control programme for childcare workers in daycare centres: A systematic review. J Pediatr Nurs. 2024;79:116–25. https://doi.org/10.1016/j.pedn.2024.09.002.
31. World Health Organization. Process of translation and adaptation of instruments. Geneva: World Health Organization. 2016. https://www.who.int/substance_abuse/research_tools/translation/en/. Accessed 6 Jul 2025.
32. Oluwabusolami E, Maitanmi J. Caregiver's knowledge and practice of infection preventive measures in childcare centers in Ogun state Nigeria. Equity J Sci Technol. 2025;11(1):29–36. https://doi.org/10.4314/equijost.v11i1.5.
33. Arlinghaus KR, Johnston CA. Advocating for Behavior Change With Education. Am J Lifestyle Med. 2018;12(2):113–6. https://doi.org/10.1177/1559827617745479.
34. Kadykalo AN, Buxton RT, Morrison P, Anderson CM, Bickerton H, Francis CM, et al. Bridging research and practice in conservation. Conserv Biol. 2021;35(6):1725–37. https://doi.org/10.1111/cobi.13732.
35. Di Gennaro F, Segala FV, Papagni R, De Vita E, Guido G, Frallonardo L, et al. Knowledge, practices, educational needs and hospital engagement in Infection Prevention and Control (IPC) among Italian healthcare workers and students: results from a national multicentre survey. JAC Antimicrob Resist. 2025;7(3):dlaf081. https://doi.org/10.1093/jacamr/dlaf081.
36. Aldawsari M, Kim Lam S, Abdul Raman R, Mohd Taib N, Aboshaiqah A, Knowledge. Attitude and Practice of Hand Hygiene among Healthcare Workers Caring for Children with Leukaemia in the Paediatric Oncology Ward of King Saud Medical City, Saudi Arabia. Malaysian J Med Sci. 2023;30(4):116–31. https://doi.org/10.21315/mjms2023.30.4.11.
37. Roughan M, Khan A, Chor J. Effect of infection control education program on childcare educator knowledge and confidence. Health Promot J Austr. 2024;35(3):849–53.https://doi: 10.1002/hpja.814.
38. Al-Shatari SAH, Ghafouri TS. Knowledge, Attitude, and Practice of Nurseries' Workers toward Infection Prevention among the Children. Al-Kindy Coll Med J. 2021;17(3):168–74. https://doi.org/10.47723/kcmj.v17i3.297.
39. Tahoun MM, Hasab AAH, El-Nimr NA. Infection control in child daycare centers: logistics, knowledge, and practices of caregivers. J Egypt Public Health Assoc. 2019;94(1). https://doi.org/10.1186/s42506-019-0016-7.
40. Raykov T, DiStefano C. Evaluating change in adjusted R-square and R-square indices: a latent variable method application. Educ Psychol Meas. 2026;86(3):627–41. https://doi.org/10.1177/00131644251329178.
41. Alshagrawi S, Alhodaithy N. Determinants of hand hygiene compliance among healthcare workers in intensive care units: a qualitative study. BMC Public Health. 2024;24(1):2333. https://doi.org/10.1186/s12889-024-19461-2.
42. Issac A, Nayak SG, George R, Priyadarshini T, Jacob J. Facilitators and barriers to hand hygiene compliance among health care providers in hospital settings: a qualitative systematic review. Nurs Health Sci. 2026;28(1):e70297. https://doi.org/10.1111/nhs.70297.
43. Haenen A, Huis A, Teerenstra S, Liefers J, Bos N, Voss A, et al. Effect and process evaluation of an intervention to improve hand hygiene compliance in long-term care facilities. J Am Med Dir Assoc. 2024;25(4):591–8. https://doi.org/10.1016/j.jamda.2023.06.020.
44. Kulkarni PA, Greene MT, Saint S, Fowler KE, Jacob S, Dillon L, et al. Comparing observed with self-reported hand hygiene adherence among bedside nurses and physicians at two hospitals in the United States. Am J Infect Control. 2026;54(3):241–6. https://doi.org/10.1016/j.ajic.2025.10.032.
45. World Medical Association. WMA Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Participants. 2024. https://www.wma.net/policies-post/wma-declaration-of-helsinki/ Accessed 1 Apr 2026.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.