A THEORETICAL FRAMEWORK FOR IMPROVING HAND HYGIENE COMPLIANCE: A SYSTEMATIC REVIEW

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ABSTRACT Evidence before the COVID-19 outbreak indicated that healthcare workers' hand hygiene compliance had been low. Although hand hygiene compliance improved during the COVID-19 pandemic, it is necessary to plan a tailored and targeted hand hygiene promotion strategy to maintain these changes. Therefore, this review aimed to assess experimental theory-based studies on hand hygiene improvement to identify the best theory and constructs with higher effectiveness. The study design is a systematic review. The search strategy was developed, and Medline (PubMed), ProQuest, Web of Knowledge, Scopus, Cochrane Trials, and Science Direct databases were searched up to May 26, 2020, without time restrictions. Review Manager 5.1 software was used to determine the risk of bias. Irrelevant articles, non-original articles, non-interventional studies, and those that lacked a theoretical framework were excluded. A total of eight articles were entered into the final analysis, including three randomized clinical trials and five quasi-experimental studies. In the selected studies, different theories were reported at intrapersonal, interpersonal, and organizational levels. Moreover, some studies evaluated multifaceted interventions involving various levels of influence. Finally, we suggested an integrated multi-level approach to promote hand hygiene (IMAPH) with a comprehensive theoretical framework for designing the interventions.

Keywords: healthcare workers, hand hygiene, theory-based intervention, systematic review, multi theory model.

1. INTRODUCTION

The world is impatiently waiting for the ending time of the COVID-19. This pandemic is a potentially fatal disease caused by SARS-COV2 and is a public health emergency of international concern (Team, 2020). COVID-19 is transmitted through close contact and droplets between individuals. Thus, preventive actions are crucial to prevent its transmission (World Health Organization, 2020). World Health Organization (WHO) highlighted hand hygiene and using alcohol-based hand rub (ABHR) as the simplest and most effective measures to prevent infection and reduce the spread of COVID-19 (Jordan, 2020; World Health Organization, 2020). In this pandemic situation, everyone must comply with hand hygiene. It is imperative for healthcare workers (HCWs), who are at the forefront of the fight against this novel virus (Michie et al., 2020). During this disaster, HCWs' hand hygiene compliance may be at risk because the staff work long hours and are subject to fatigue or uncertainty about how to perform hand hygiene (Gon et al., 2020). Therefore, it is necessary to tailor strategies to improve hand hygiene compliance.

Evidence indicates a range of interventions with varied effectiveness for improving hand hygiene compliance. These interventions mainly focus on education (Sundal et al., 2017), management mechanisms (Cunningham et al., 2018), and a multi-modal program (Staines et al., 2018). According to the WHO perspective, multiple strategies effectively deal with this issue (Safety and Organization, 2009). However, it is necessary to investigate which combination of interventions can provide better results. In this regard, theoretical frameworks can draw a clear study design to understand the effectiveness of interventions and determinants more effectively.

Using theoretical frameworks for designing intervention in a health problem has many benefits, including identifying behavioral determinants, theoretical structures of behavior change, interventional methods, practical solutions, and evaluation of behavior changes (Reigeluth, 2013). Additionally, theory-based research facilitates the comparison of the effectiveness of interventions in different settings, replication of the studies, and identification of effective interventions' components.

Srigley et al. (2015) conducted a systematic review of studies with theoretical psychological frameworks and concluded that the behavior change theories provided a promising tool for promoting hand hygiene. Huis et al. (2012) also mentioned hidden components of hand hygiene improvement could be found by focusing on behavioral

determinants (Huis et al., 2012). Although the past systematic reviews have focused on theoretical psychological and behavioral frameworks, the more important question is how much theory-based interventions are successful. What determinants and at what level of influence are more significant in hand hygiene compliance? And possibly, what combination of theories or determinants can have more success and effectiveness in promoting hand hygiene?

Evidence before the COVID-19 outbreak indicated that healthcare workers' hand hygiene compliance was low, with a mean compliance rate of 38.70% (Cunningham et al., 2018). Despite improvement in hand hygiene compliance during the COVID-19 pandemic, previous studies have shown the necessity of planning a tailored and targeted hand hygiene promotion strategy to maintain these changes (Alzyood et al., 2020; Assefa et al., 2021). Therefore, the present systematic review aimed to explore theory-based interventions on hand hygiene compliance to determine the appropriate strategies at different levels of influence. In this way, we hope to introduce a more effective and comprehensive theoretical framework for improving hand hygiene compliance in health care settings, which can remain consistent during epidemics and post-epidemics.

2. MATERIALS AND METHODS

2.1 Search strategy

Medline (PubMed), ProQuest, Web of Knowledge, Scopus, Cochrane Trials, and Science Direct databases were searched until May 26, 2020, without time restriction for accessing all possible published articles in this field. The references of relevant articles were also searched for additional studies. The search strategy is indicated in Appendix A. The collected data were entered into the EndNote X7 software, and duplicate articles were excluded.

2.2 Study selection and inclusion criteria

The inclusion criteria in this systematic review were interventional studies (randomized clinical trials and quasi-experimental) that had applied a theoretical framework to design interventions for improving hand hygiene compliance. The exclusion criteria were the articles without full text, non-original articles, and non-English language articles.

2.3 Data extraction and management

This study was conducted using a systematic review methodology for qualitative synthesis recommended by Joanna Briggs Institute (JBI) (Moola et al., 2015). Data extraction was implemented using a data

extraction form by one reviewer, and a second reviewer confirmed the accuracy of the extraction. The data extraction form was designed based on the required items in this study, including population, study design, country of origin, theory framework, and intervention details.

2.4 Risk of bias in included studies

The risk of bias was determined using Review Manager 5.1 software. Figure 1 presents the risk of bias of items (in percent) related to all articles included in the systematic review. Also, Figure 2 shows the details of the risk of bias items related to each separate article.

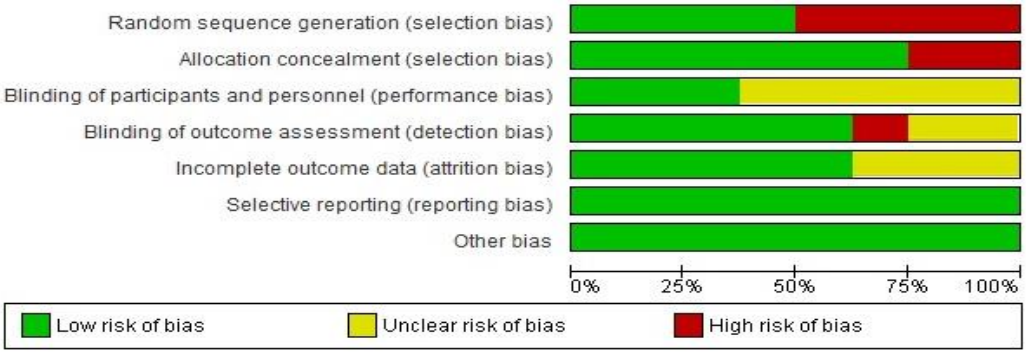

Figure 1. Risk of bias graph: review authors' judgments about each risk of bias item expressed as percentages across all included studies

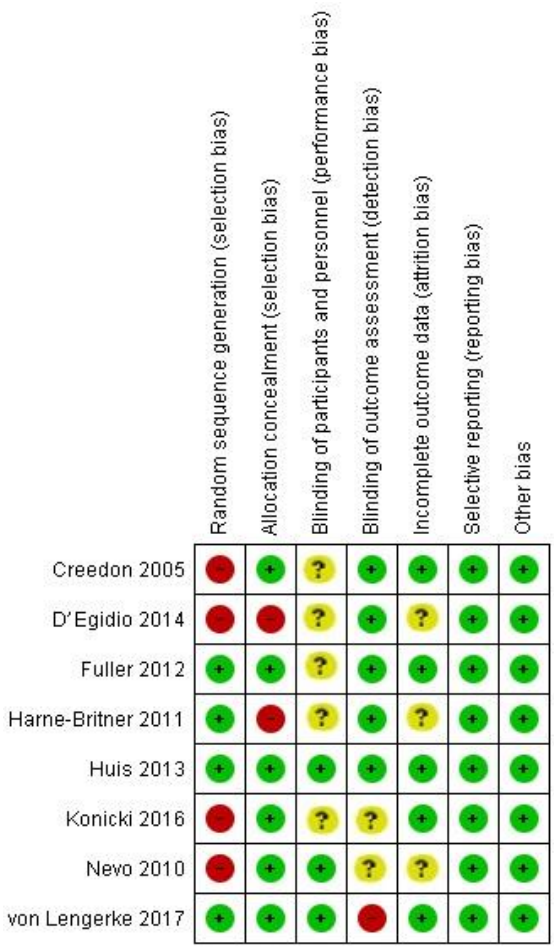

Figure 2. Risk of bias summary: review authors' judgments about each risk of bias for each included study

3. RESULTS

3.1 Description of studies

Searching for Medline (PubMed), ProQuest, Web of Knowledge, Scopus, Cochrane Trials, and Science Direct databases resulted in 128 articles. After the omission of duplicate studies, 70 articles were evaluated based on the titles and abstracts. After investigating the titles and abstracts, 18 articles were entered into the next stage, and their full texts were used in the analyses. Eventually, 8 articles, including 3 Randomized Clinical Trials (RCTs) and 5 quasi-experimental studies, were entered into the final analysis. The irrelevant articles, non-interventional studies, non-original articles, and those that did not include theories were excluded through screening. The flowchart for selecting the studies meeting the inclusion criteria is provided in Figure 3.

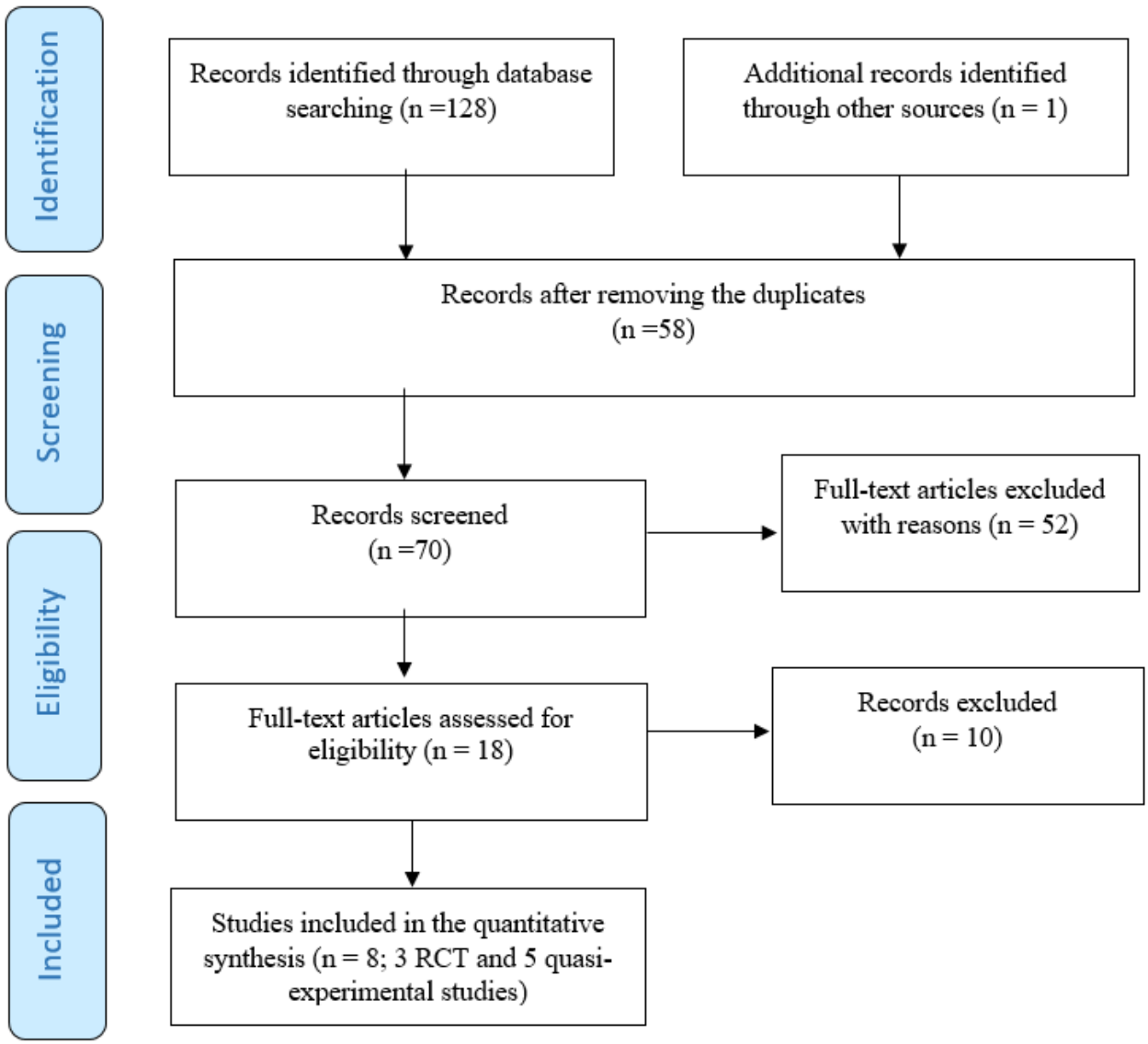

Figure 3. Search process and systematic identification review of studies with a theoretical framework in hand hygiene intervention in healthcare workers

3.2 Study characteristics

Of the 8 selected randomized controlled trials and quasi-experimental studies for systematic review, 3 had been conducted in the USA and the rest in the Netherland, Canada, Germany, the UK, and Ireland. The theoretical framework varies, including HAPA, SCT, attention theory, social learning theory, social influence theory, the theory of team effectiveness, leadership theory, goal setting theory, control theory, change theory, and PRECEDE. The characteristics of the studies are summarized in Table 1.

Table 1. Summary of the included studies in this systematic review

STUDY	REGION	DESIGN	PARTICIPANTS	THEORETICAL FRAMEWORK
Von Lengerke (2017)	Germany	Cluster RCT	Physicians Nurses	Health Action Process Approach (HAPA)
Konicki (2016)	The USA	Quasi-experimental	Nursing students	Social Cognitive Theory (SCT)
D' Egidio (2014)	Canada	Quasi-experimental	HCWs	Attention theory
Huis (2013)	The Netherlands	Cluster RCT	Nurses	Social learning theory Social influence theory Theory of team effectiveness
Fuller (2012)	The UK	Cluster RCT	HCWs	Leadership theory Goal setting, control, and operant learning theories
Nevo (2010)	The USA	Quasi-experimental	Physicians Nurses	HBM
Harne-Britner (2011)	The USA	Quasi-experimental	HCWs	Change theory and aspects of behavioral, social science, and organizational theories
Creedon (2005)	Ireland	Quasi-experimental	HCWs	PRECEDE

Based on the overall critical risk-of-bias items, all 8 articles were rated as low risk of bias (studies with three or more items were considered low risk). Also, 5 (62.5%) studies were identified as unclear risk of performance, indicating that the blindness of the participants was unclear. In 1 study, the assessor was not blind to the research, and

there was an unclear risk of detection bias in 2 articles; also, attrition rates were clearly reported in 5 articles (Figure 2).

4. DISCUSSION

While efforts to develop the COVID-19 vaccination and treatment are underway, health and socio-behavioral sciences can provide non-pharmaceutical interventions to manage and sustain public health measures and slow the spread of the virus. One of the most critical health measures to prevent transmission of COVID-19 is hand hygiene compliance in all populations, especially health care workers. This systematic review aimed to explore studies that use the theoretical framework for designing interventions to improve hand hygiene in hospitals. The review of the studies revealed that they targeted various determinants at different levels of intrapersonal, interpersonal, and organizational influences. In the following, the importance of each determinant is identified at each influence level, and the authors' proposed approach is presented to design a new intervention.

According to the results, individual determinants are the first levels of influence on complying with hand hygiene focusing on behavioral change theories. Individual predictors of behavior change reviewed in the mentioned articles included outcome expectancy and self-efficacy (Konicki and Miller, 2016), goal setting (Fuller et al., 2012), risk perception and self-regulatory efforts (von Lengerke et al., 2017), and attention (D'Egidio et al., 2014). In line with our results, Carico et al. (2020) stated that the Health Belief Model (HBM) as an individual theory (including perceived threat, perceived barriers, perceived benefits, perceived self-efficacy, and cues to action) can help strengthen COVID-19 prevention behaviors. Other researchers also concluded that health decisions (e.g., hand washing during the COVID-19 pandemic) depend on correct perceptions of the costs and benefits of some choices for oneself and others (Pakpour and Griffiths, 2020, Von Lengerke et al., 2013). This conclusion highlights the outcome expectancy that is individual beliefs about the costs and benefits of performing the targeted behavior (Sundal et al., 2017). Schwarzer et al. (2011) stated that goal setting, as a stimulant to conduct hand hygiene behaviors, facilitated the conversion of intention to behavior.

One of the other levels of influence is interpersonal determinants. This level

includes reciprocal effects between the members of a social network. Individuals in close social interaction can inform and remind each other about certain behaviors (Lemieux-Charles et al., 2002). The reviewed studies highlighted interpersonal factors of health behavior with interpersonal theory frameworks, including team effectiveness theory, social influence theory, Bandura's social learning theory, control theory, and operant learning theory (Huis et al., 2013;Fuller et al., 2012; Harne-Britner et al., 2011). In line with the present study, other researchers indicated that people's behavior is influenced by social norms and approval from others; and people try to conform to norms and learn from others (Cialdini and Goldstein, 2004; Wood, 2000).

Christakis et al. (2013) stated that social networks could increase the range of useless and useful behaviors during an epidemic. Kim et al. (2015) also explained that powerful people in the center of networks are influential in slowing the disease because they can play a positive role in modeling the spread of beneficial behaviors among people.

The findings showed that organizational determinants, as another level of influence, have greater effectiveness in interventions because the employees' behavior in an organization is severely influenced by organizational policies, rules, climate, culture, and behavior (Young and Ghoshal, 2016). Organizational strategies and programs can also affect the intrapersonal and interpersonal levels and facilitate hand hygiene compliance.

In the reviewed studies, organizational determinants included the role of charismatic leaders in building a collective agreement (leadership theory), the provision of facilities (Huis et al., 2013), the use of visual cues to change the texture of behavior (Nevo et al., 2010), and giving rewards (theory of change) (Harne-Britner et al., 2011). Fransen et al. (2015) stated that effective leadership could create collective efficacy. Van Bavel et al. (2020) found that without leadership during the COVID-19 pandemic, the situation of 'everyone for him/herself' will be created; as a result, people will not help each other and only look after themselves. Greyling et al. (2016), consistent with this finding, realized that the religious leaders were excellent advocates of health measures such as hand hygiene during the Ebola crisis. Loftus et al. (2019) mentioned that the decreased accessibility of

ABHR is a challenge that prevents effective hand hygiene procedures in resource-limited healthcare settings. Therefore, it is necessary to make changes in providing personal protective equipment and facilities during COVID-19 in health care settings (Hargreaves et al., 2020; Organization, 2020).

Results analysis showed that some reviewed studies had used multifaceted approaches to design their interventions (Creedon, 2005; von Lengerke et al., 2017). In this respect, von Lengerke et al. (2017) carried out their study based on the HAPA model, and Creedon et al. (2005) used PRECEDE model. Certainly, the design of interventions in these two studies was not purposeful and systematic; thus, they were not effective enough. It seems that theoretical frameworks will be more effective by taking a multifaceted approach and paying attention to all three levels of individual, interpersonal and organizational.

Proposed integrated multi-level approach:

Given the huge transmission power of the COVID-19, it is necessary to start effective planning for complying with hand hygiene. The review of successful interventions indicates that they affect different levels. Since the impact on hand hygiene adherence requires more precise strategies covering intrapersonal, interpersonal, and organizational levels, it is necessary to use more comprehensive theoretical frameworks in designing interventions.

Overall, it is possible to extract a better framework for designing the interventions and increase the likelihood of the effectiveness of interventions using the appropriate theory. Schölmerich et al. (2016) suggested that multi-level interventions inspired by socio-ecological models can provide better outcomes in behavioral change. Sharma (2015) proposed a multi-theory model in his new article. According to this author, changing health behavior can be established with the environmental, cognitive, and conative components, including a combination of theories at the individual, group, and social levels. This holistic theory is culturally influential and can be used in environments with limited resources. Therefore, we suggest an integrated multi-level approach to promote hand hygiene (IMAPH) based on the existing evidence and our professional experiences in the clinical practice, including intrapersonal, interpersonal, and organizational

components. The strength of this multi-theory model is that it can guide interventions at different levels of intrapersonal, interpersonal, and organizational. As a result, they synergistically increase the effectiveness of hand hygiene interventions compared to using one theory. Another strength of using multifaceted interventions is the ability to change behaviors that can be sustained in the long run. The limitations of this multi-theory model are the difficulty of implementation, higher costs, and the need for more manpower and comprehensive management to implement it. Since it is important to improve hand hygiene compliance at all times, especially during pandemics, promoting hand hygiene using this model in the clinical setting can prevent the transmission of these diseases to staff, patients, and their families, thereby its prevalence in society. A schematic plan of this approach is presented in Figure 4, and a model including IMAPH with details is in Table 2.

In the first stage of this framework, some structures with the intrapersonal function borrowed from different theories were used to improve the factors at the intrapersonal level. These structures include improving external cues to action, attention, motivation, risk perception, and efficiency. Designing interventions according to them improves a person's beliefs, perception, intention of behavior, and self-efficacy and ultimately improves hand hygiene behavior.
In the second stage, using social theories and teamwork, we sought positive social influence and proposed establishing norms and values that strengthen and support hand hygiene behavior. The purpose of interventions at this level is to promote a supportive and rewarding social environment in favor of adherence to hand hygiene.

The third level was formed according to the principle that a sustainable behavioral change needs supportive leaders and managers and a supportive climate and environment. Therefore, improving equipment and training and changing organizational perspective, policy, and climate to promote hand hygiene are recommended. Based on these three steps, the long-term outcomes of implementing interventions will be improving hand hygiene compliance and reducing nosocomial infections.

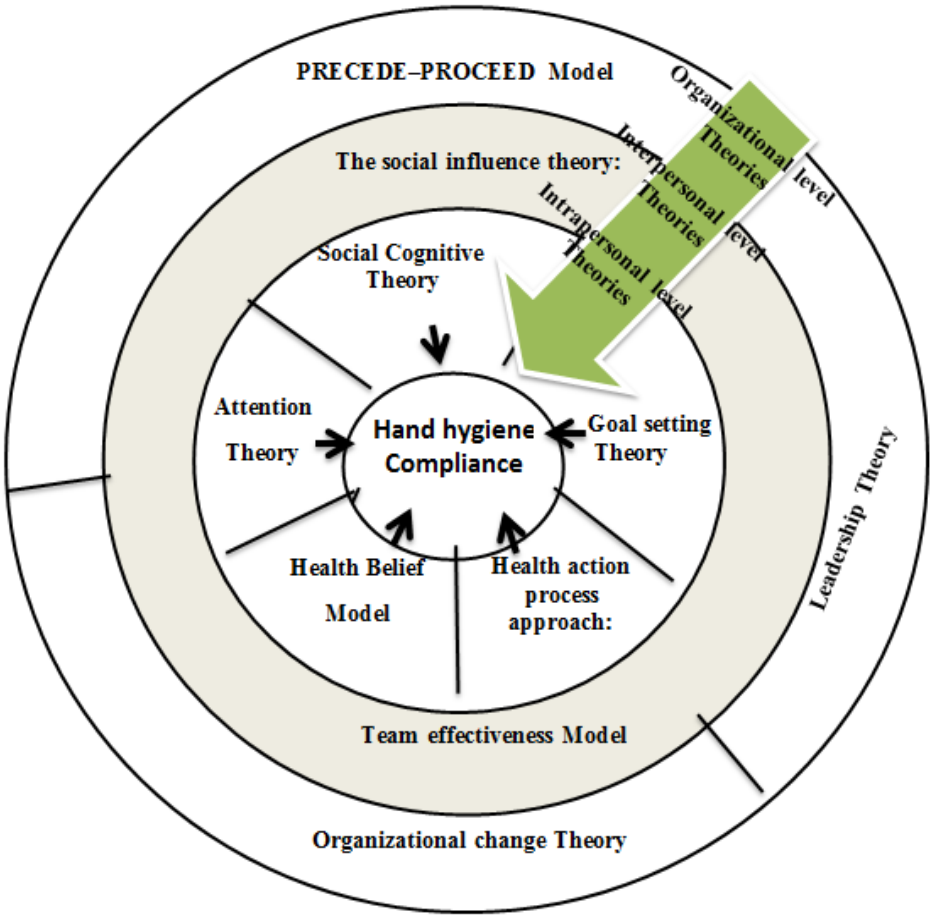

Figure 4. Proposed integrated multi-level approach for promoting hand hygiene compliance (IMAPH) based on this systematic review

Table 2. An integrated multi-level approach to promote hand hygiene (IMAPH) with details

	Theories	Change objectives	Activities	Short-term outcomes	Long-term outcomes
Intrapersonal level theory	**Health belief model** (Champion and Skinner, 2008)	-External cues to action	- Put visual warning cues for hand washing on the doors or on top of the sink in the patients' rooms	- Improved behavioral intention	Improving hand hygiene compliance & reducing nosocomial infections
	Goal-setting theory (Locke and Latham, 2013)	-motivation	- Encourage nurses to set goals such as achieving a 98% reduction in nosocomial infections within two months	-Improved belief - Improved behavior	
	Health action process approach(Schwarzer, 2016)	-Risk perception	- Take a microbial sample from the health care workers' hands and tell them the results	Increased risk perception	
	Attention theory (Wickens and McCarley, 2019)	-Attention	- Put a small flashing red light on the wall-mounted hand sanitizer dispenser	-Improved perception & behavior	
	Social cognitive theory (Schunk, 2012)	-Efficacy	-Use a reward system to motivate staff in the wards, if they regularly comply with hand hygiene	- Self-efficacy	
Interpersonal level theory	**The social influence theory** (Treadway et al., 2013)	-Values and norms	- Employ a nurse with an appropriate value system and charismatic personality as a role model for colleagues in each ward.	-Improved attitude, belief, and behavior	
	Team effectiveness model (Omar and Ahmad, 2014)	-Effectiveness	- Create teams and establish values and goals. Members of a team can influence each other to achieve maximum adherence to hand hygiene	-Improved attitude, belief, and behavior	
Organizational level theory	**Organizational change theory** (Battilana and Casciaro, 2012)	-Organizational environment	- Provide sufficient and appropriate equipment and facilities for observing hand hygiene - Increase hand washing stations in the hospital - Increase the number of educational workshops	-Supportive environment	
	Leadership theory (Lussier and Achua, 2015)	- Perspective	- Use charismatic leaders and managers to create a collective perspective	-Supportive leaders and managers	
	PRECEDE-PROCEED model (Gielen et al, 2008)	-Laws and policies -Organizational climate	- Establish the same rules and regulations for hand hygiene for all occupations of the hospital - Get creative rewards for the best wards and teams in hand hygiene compliance - Regularly monitor wards for nosocomial infections and provide penalties for words with the most nosocomial infections and retrain people.	-Supportive climate	

5. CONCLUSION

The overall result of this systematic review revealed that the interventions are more effective when they are designed based on various determinants and levels. Finally, we proposed an integrated multi-level approach to promote hand hygiene (IMAPH) that included the constructs of various theories that can be used to design interventions for improving hand hygiene compliance at all times, especially in the era of COVID-19. It is recommended to design an intervention based on IMAPH and the socio-ecological framework to improve hand hygiene compliance and implement it in several hospitals.

The limitation of this study was the lack of standard specifications for different levels of influence. For instance, the interventions' type, dose, and duration were different, which made it difficult to compare different studies. Moreover, different designs of studies and non-specification of hand hygiene compliance percentages caused the researcher not to be able to compare the influence levels of the interventions with meta-analysis.

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