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A systematic review of nudges on hand hygiene against the spread of COVID-19

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ABSTRACT

The COVID-19 pandemic has posed the greatest threat to global health over the last three years. Due to the temporary shortage of appropriate vaccines, a systematic change in human behaviour is necessary to keep the spread of the virus under control, increasing the quality of basic hygiene practices, such as systematic hand hygiene. Nudges are increasingly used in public health interventions to promote critical preventive hygiene behaviours. This review aimed to investigate the effect and the characteristics of nudges on hand hygiene, as a COVID-19 preventive measure. We systematically reviewed the relevant literature from January 2008 to November 2020. A total of 15 articles met the inclusion criteria. The findings of this review showed that most of the nudging interventions had a positive effect on hand hygiene. Nudges should be included in the existing and future public health interventions to prevent the spread of COVID-19 and future pandemics, rather than being an alternative and unconventional tool for public health policies.

1. Introduction

On March 11, 2020, the World Health Organization (WHO) declared the pandemic of the new coronavirus COVID-19 (WHO, 2020). The coronavirus disease is a highly infectious disease and has spread very fast all over the world. Due to the temporary shortage of appropriate vaccines at the early stages of the pandemic, a systematic change in human behaviour was necessary to keep the spread of COVID-19 under control, increasing the quality of basic hygiene practices, such as systematic hand hygiene (Wilder-Smith & Freedman, 2020).

The COVID-19 pandemic is a strong reminder that one of the most important, simplest and cost–effective ways to reduce the spread of the virus is hand hygiene. Hand hygiene is referring to as any action of hand cleansing by either washing them with soap and water, or by using an alcohol-based hand sanitising gel, following the appropriate handwashing practices (WHO, 2009). Hand hygiene is a preventive behaviour, which is determined by a range of psychological, social, emotional, environmental and habitual factors (Dreibelbis et al., 2013).

Hand hygiene is especially important when done at the right time, with the right tools (soap and water or with sanitiser gel) and with the appropriate technique. The World Health Organization (WHO) recommends continuous hand hygiene and regular cleaning, as these kill the viruses that may be on the hands (WHO, 2020). The systematic review of Saunders-Hastings et al. (2017) showed that frequent hand- washing has a large and significant protective effect against a pandemic influenza. Increased hand hygiene is associated with lower hospitalisation rates (Godoy et al., 2012) and absenteeism during a seasonal flu (Azor-Martínez et al., 2014). It also protects against a number of other diseases such as the common flu, diarrhoea (Rabie & Curtis, 2006) and pneumonia (Ejemot et al., 2008). A meta-analysis in 2018 states that hand-washing with soap and water can reduce diarrhoea by 23% - 48% (Wolf et al., 2018) and respiratory infections by 21% −23% (Rabie & Curtis, 2006).

Public health policies set the encouragement and immediate adoption of preventive behaviours as their primary objective to protect population health. Promoting hand hygiene compliance is a key core of public health, as proper hand hygiene is one of the most important preventive behaviours against pathogens (Saunders-Hastings et al., 2017).

Traditional approaches to promoting hand hygiene, including providing information about the risks of poor hygiene, have shown limited effectiveness. An effective behaviour change requires more than just educational and informational campaigns (Kelly & Barker, 2016). Nudges received considerable attention in recent years and contributed to several fields of public health, one of those is hand hygiene (Congdon & Shankar, 2018).

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The nudge concept was developed by Thaler & Sunstein (2008) in a seminal book for public policy, and the public perception of behavioural economics. A nudge is "any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives" (Thaler & Sunstein, 2021, p. 8).

Researchers and policy-makers are increasingly recognising the importance of nudges in decision-making, and the ability to reap significant benefits through relatively small changes in human decisions (Madrian, 2014). Nudges have been widely used in conducting experiments and research in the context of improving decision-making. Some of these areas of research are energy consumption (Rasul & Hollywood, 2012), environmental protection (Sunstein & Reisch, 2014), finance (Cai, 2020) and health (Chapman et al., 2010; Madrian, 2014). Nudges have been introduced into the field of public health to contribute to the promotion of desirable behaviours that promote personal and public health such as smoking cessation and healthy food choices (Sunstein, 2015; Vallgarda, 2012).

The current systematic review aimed at investigating the effect and the characteristics of nudges on hand hygiene, as a COVID-19 preventive measure.

2. Method

The review was performed according to the PRISMA method (Moher et al., 2009).

2.1. Search strategy

A systematic review of the international literature on nudging interventions targeting hand hygiene, in four electronic databases (PubMed, Google Scholar, Cochrane Library, Mendeley) was conducted between January 1, 2008 (publication year of Thaler and Sunstein's seminal book on nudging) and November 20, 2020. The focus of the search was to mostly identify those interventions which were experimentally evaluated and described as behaviourally-tested by Lourenço et al. (2016). This search included all possible combinations of two keyword blocks of terms such as "hand hygiene", "hand-washing", "hand sanitiser use" and "nudges", "nudging interventions". Additional eligible articles were identified by checking reference lists of the articles that met the inclusion criteria.

2.2. Study inclusion criteria

The selected studies were eligible if they met the following inclusion criteria: (1) they had to have been published from January 1, 2008 to November 20, 2020, (2) they had to be original studies, (3) they had to have used concepts of nudges in hand hygiene and (4) they had to have been written in English.

2.3. Selection process

After searching a database for relevant articles, the identified articles were merged in order to identify and delete duplicates. The screening

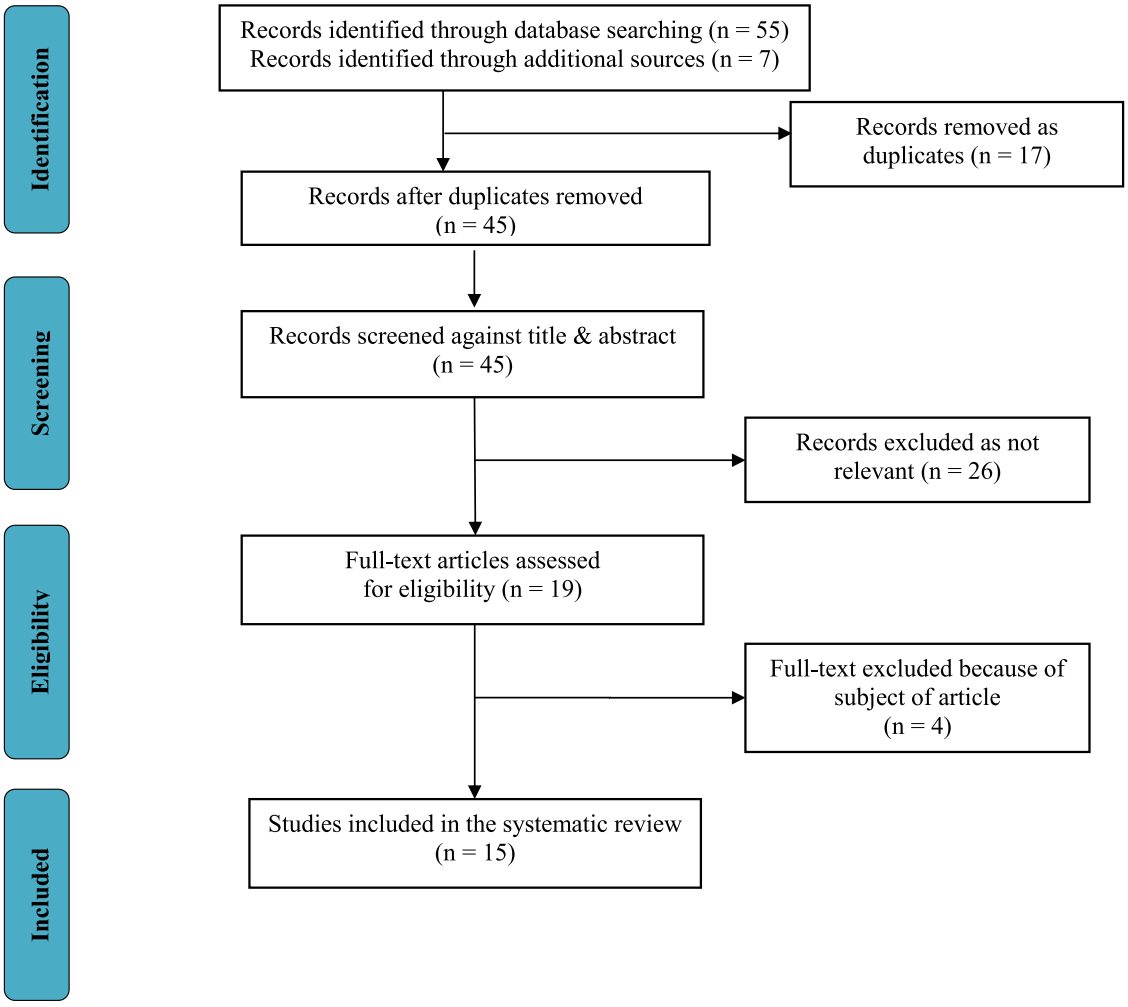

Fig. 1. PRISMA flow diagram (Moher et al., 2009).

process was completed in two steps. The relevant articles were initially screened for eligibility based on their titles and summaries. Then, full text articles were further studied for eligibility and checked that the above-mentioned inclusion criteria were satisfied (see Fig. 1).

3. Results

Initially, 62 articles were identified. After excluding duplicates (n = 17), 45 articles were assessed and 26 of them were removed as non-relevant after the reading of the titles and the abstracts. Nineteen full-text articles were assessed against our inclusion criteria and 4 of them were excluded because of the subject, as they related to a topic other than nudging interventions. A total of 15 articles were included in this systematic review. The flowchart of this process is shown in Fig. 1.

3.1. Characteristics of the included studies

Table 1 presents the main characteristics of the included studies in this review.

3.1.1. Country & publication year

The earliest included study was published in 2008, followed by two studies in 2009. For the next 4 years, no relevant study was published. From 2014 onwards, the number of publications increased with most being identified in 2018 (n = 5), while in 2016 and 2020 (until November) 3 studies were identified respectively.

Most studies were conducted in the USA (n = 4), followed by Germany (n = 3), then Bangladesh (n = 2) and then the UK, Norway, Denmark, The Netherlands, Australia and Thailand.

3.1.2. Setting and duration of interventions

The duration of the interventions varied considerably from 5 days to 17 weeks. Three studies lasted 4 weeks and 6 weeks respectively, followed by two studies lasting 13 weeks. Most studies were conducted in hospitals (n = 7). The rest of the studies took place in universities (n = 5), schools (n = 2) and a national highway service station (n = 1).

3.1.3. Nudging interventions

The nudging interventions included in the reviewed articles were analysed and presented in Table 1. Interventions were grouped based on their similar characteristics in order to have a comprehensible overview and be connected with established behaviour change frameworks such as MINDSPACE (Dolan et al., 2011). Social norms and priming were the most commonly used strategies of the included articles. Social and cultural norms, affect (e.g. disgust) and priming were used in messages and posters. Priming included visual cues such as images and olfactory interventions. Salience and priming included environmental cues and an increase in accessibility. The reviewed studies below are grouped according to the means that were used to implement the intervention.

1 *Use of messages:* two studies projected messages to measure their impact on hand hygiene in public toilets. Botta et al. (2008) used threatening messages to motivate hand-washing behaviours in university students living on campus. Judah et al. (2009) used messages in seven psychological domains such as knowledge of risk and activation, social norms, status, comfort, disgust and cue on the national highway service station restrooms.
2 *Use of images:* Three studies used images such as eyes (male - female) (Gaube et al., 2018; King et al., 2016; Pfattheicher et al., 2018) close to manual soap dispensers or electronic devices with hand sanitiser gel and images of emoticons close to washbasins (Blackwell, 2018).
3 *Use of posters (image and message combination):* three studies made simultaneous use of message signs with an image. One study displayed posters on a TV screen in close proximity to hand sanitiser gel devices (Gaube et al., 2020). Another study used posters on two hospital wards to measure their impact on hand hygiene (Caris et al., 2018), while another intervention placed disgust-inducing posters in washrooms (Porzig-Drummond et al., 2009).
4 *Visual cues and olfactory:* two studies used sensory cues to activate the visual response and the sense of smell. One used the clean, fresh smell of citrus (King et al., 2016) while another intervention used motion activated towel dispensers to increase hand-washing compliance (Ford et al., 2014).
5 *Environmental cues:* Three studies used special pathways with markings such as footprints, handprints or directional arrows to encourage participants to follow the corresponding pathways to the hand-washing stations (Blackwell, 2018; Dreibelbis et al., 2016; Grover et al., 2018). Also, in one study a footprint marking was attached to a foot pedal-operated hand sanitiser gel dispenser (Wichaidit et al., 2020).
6 *Increasing ease of access*: These interventions are related to the repositioning and improving the accessibility of hand sanitiser gel to the public in combination with the use of messages. A total of 2 studies used this approach where they placed floor stands with hand sanitiser gel using messages at key locations of hospitals (Aarestrup et al., 2016; Mobekk & Stokke, 2020).

3.1.4. Measurement methods

Seven of the fifteen studies (Aarestrup et al., 2016; Botta et al., 2008; Dreibelbis et al., 2016; Grover et al., 2018; King et al., 2016; Mobekk & Stokke, 2020; Wichaidit et al., 2020) used direct observations to collect their data that varied between each study. For example, some of them concentrated solely on whether people used hand sanitiser or not or whether hands were washed with soap, or the length of hand-washing and whether individuals washed both hands. The data of the eight remaining studies (Blackwell, 2018; Caris et al., 2018; Gaube et al., 2018, 2020; Ford et al., 2014; Judah et al., 2009; Pfattheicher et al., 2018; Porzig-Drummond et al., 2009) were collected remotely, via electronic devices that measured product volume and electronic motion detectors that recorded whether or not people performed hand hygiene behaviour by using soap or hand sanitiser.

3.1.5. Effectiveness of interventions

According to Table 1, the included studies showed that nudging interventions had a positive effect on hand hygiene and reported at least one significant effect, which was mostly reported as p- value of 0.05 or lower. Two of the studies reported a small to moderate effect size (Blackwell, 2018) and a small effect size (Gaube et al., 2020), respectively. Overall, the statistically significant relative increase ranged from 6.4% (Judah et al., 2009) to 2133.3% (Aarestrup et al., 2016) over the baseline rates.

Two of the studies reported mixed results, as they stated that images with female eyes had no significant effect on hand hygiene (Gaube et al., 2018; King et al., 2016), while hand hygiene was significantly increased when an image of male eyes was used. The image of a smiling emoticon had a positive effect on men, while it had no effect on women (Blackwell, 2018). Judah et al. (2009) found that males and females had different responses to health promotion messages.

4. Discussion

Nudging interventions in proper hygiene and prevention practices, such as hand hygiene, have shown promising results and can be a crucial practice against the spread of COVID-19.

The COVID-19 pandemic intensified the need to maintain hand hygiene, which is considered a simple and cost-effective practice. Hand hygiene is associated with limiting the transmission of harmful germs and preventing a disease (WHO, 2009). Therefore, it is of the utmost importance for nudges to continue in this direction since they are successful in encouraging immediate behavioural changes.

Thus, the current systematic review highlights the importance and impact of nudging on hand hygiene to protect public health. The core

Table 1
Characteristics of the included studies.

Author(s), Year	Purpose	Country	Place of intervention	Target group	Duration of intervention	Nudging interventions	Data collection	Findings	Effect
Aarestrup et al., 2016	To examine whether coloured signs with dispenser placements that emphasise hand sanitiser use could improve hospital visitors' hand hygiene.	Denmark	Gentofte hospital	Hospital visitors	5 days	Colour sign message & dispenser placements.	Direct observations	Hand hygiene increased significantly during the intervention periods.	(+) Significant effect of the new placement & the sign on hand sanitiser gel usage. $\chi^2(2) = 14.45$, $p < 0.01$
Blackwell, 2018	To examine whether nudging cues could influence hand-washing behaviour in public restrooms on the campus of a medium-sized university.	USA	The College of Charleston Beatty center	University students	8 weeks	Visual cues: smiley face-emoji & arrow shaped pathway.	Indirect observations with soap dispensers	Hand-washing increased significantly during the arrow treatment. Smile treatment was not statistically significant.	(+/-) Significant effect of the arrows on hand-washing. Cohen's $d = 0.39$, small to moderate effect. Effect size = 19.15%. Smiles had not significant effect on females $p>0.05$
Botta et al., 2008	To examine the effectiveness of threat messages on hand-washing behaviour on a university campus.	USA	Campus dorms in a mid-sized university	University students' dorm residents	4 weeks	Threatening messages.	Direct observations	Hand-washing increased significantly during the intervention period.	(+) Significant effect of the threatening messages on hand-washing ($p < 0.01$).
Caris et al., 2018	To investigate whether behavioural nudges, displayed as posters, can increase the use of alcohol-based hand rubs.	The Netherlands	Hospital wards	Healthcare personnel	6 weeks	Posters (images & slogans).	Electronic dispensers	Hand sanitiser gel usage increased significantly during the intervention period.	(+) Significant effect of the posters on hand sanitiser gel usage. Poster 1: RR 1.6 95% CI: 1.2–2.2; Poster 2: RR 1.17(1.2–2.5)
Dreibelbis et al., 2016	To examine if nudging interventions can encourage hand-washing behaviour after using the toilet.	Bangladesh	2 primary schools in rural Bangladesh	Primary school students	6 weeks	Bright coloured pathway, footprints & handprints to the hand-washing stations.	Direct observations	Hand-washing increased significantly during the intervention periods	(+) Significant effect of the footpath & painting on hand-washing behaviour after using the toilet ($p < 0.05$).
Ford et al., 2014	To investigate the efficacy of a simple, visual cue to increase hand-washing with soap and water in public restrooms.	USA	North Carolina University campus	University students	10 weeks	Visual cue: automated towel dispensers.	Wireless sensors	Hand-washing compliance increased by a visual cue.	(+) Significant effect of a visual cue on hand-washing compliance (χ^2 goodness-of-fit test, $p = 0.003$)

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Table 1 (*continued*)

Author(s), Year	Purpose	Country	Place of intervention	Target group	Duration of intervention	Nudging interventions	Data collection	Findings	Effect
Gaube et al., 2020	To examine whether persuasive message signs help to improve visitors' hand hygiene behaviour in a hospital's lobby.	Germany	Rottal Inn Hospital	Hospital visitors	14 weeks	Message signs with photos displayed on the TV screen.	Electronic sensor system	Hand sanitiser gel usage increased significantly during two sign interventions (authority & social proof principles).	(+) Significant effect of the signs on hand-rub dispenser usage. Authority: Cohen's d = 0.23 (small effect). Effect size = 11.14%. Social-proof: Cohen's d = 0.12 (small effect). Effect size= 6%
Gaube et al., 2018	To study whether or not visual reminders that activate social norms affect hand hygiene behaviour.	Germany	Rottal Inn Hospital, Eggenfelden	Trauma surgery patient rooms	17 weeks	Emoticons and watching eyes. displayed on the TV screen.	Electronic sensor system	Hand sanitiser gel usage increased significantly only during the emoticon-based feedback system intervention.	(+/-) Significant effect of emoticons on hand-rub dispenser usage F (2,2)= 44.702, p = 0.22. Female eyes had no significant effect.
Grover et al., 2018	To investigate the impact of nudges on hand-washing behaviours amongst primary school children as compared to a high-intensity hygiene education intervention.	Bangladesh	20 primary schools in rural Bangladesh	Primary school students	4 weeks	Bright coloured pathway, footprints & handprints to the hand-washing stations.	Direct observations	Hand-washing increased significantly during the nudging & the hygiene education interventions.	(+) Significant effect of the footpath & painting on hand-washing behaviour after using the toilet (IRR 1.58 95% CI: 1.20–2.08)
Judah et al., 2009	To investigate interventions that derived from different domains of behaviour change theory to determine their effectiveness at increasing hand-washing with soap & water.	UK	Highway service station restrooms	Travelling public	3 months	Text-only messages displayed on an electronic dot matrix screen.	Wireless sensors	Hand-washing increased significantly during the interventions that were based on social norms & social status messages.	(+) Significant effect of the social norms & social status messages on hand-washing (p = 0.001).
King et al., 2016	To examine whether priming via olfactory and visual cues influences hand hygiene compliance.	USA	Surgical intensive care hospital in Miami	Health professionals & Hospital Users	3 months	Olfactory (citrus smell) & Visual prime (watching eyes).	Direct observations	Hand hygiene increased significantly during the olfactory scent and male eye interventions.	(+/-) Significant effect of olfactory scent and male eyes on hand-rub dispenser usage (p < 0.05). Female eyes had no significant effect (p > 0.05).

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Table 1 (*continued*)

Author(s), Year	Purpose	Country	Place of intervention	Target group	Duration of intervention	Nudging interventions	Data collection	Findings	Effect
Mobekk & Stokke, 2020	To examine whether coloured signs that emphasise hand sanitiser use could improve hospital visitors' hand hygiene.	Norway	Oslo university hospital	Hospital visitors	3 weeks	Colour sign message on hand sanitisers.	Direct observations	Hand sanitizer gel usage increased significantly during the sign intervention.	(+) Significant effect of a sign on hand-rub dispenser usage $\chi^2(2)=41.23$, $p<0.05$
Pfattheicher et al., 2018	To study if individuals show stronger hand hygiene compliance when being watched.	Germany	Public restroom on a university campus	Women's public restroom	1 month	Watching eyes poster.	Smart soap dispensers	Hand-washing compliance increased significantly during the watching eyes condition.	(+) Significant effect of a watching eyes poster on hand-washing compliance (OR 1.95, $p=0.1$)
Porzig-Drummond et al., 2009	To examine whether the emotion of disgust increases the hand-washing rates.	Australia	University library washrooms	University students	6 weeks	Disgust-inducing poster.	Indirect observations, measuring soap & paper towel usage	Hand-washing rates increased significantly during the disgust-based intervention.	(+) Significant effect of a disgust-inducing poster on hand-washing compliance. $t(7)=2.72$, $p<0.05$
Wichaidit et al., 2020	To investigate whether nudges can increase the use of alcohol-based hand rubs amongst outpatient visitors.	Thailand	Hospital in southern Thailand	Outpatient hospital visitors	9 days	A sign and a footprint marking were attached on gel dispenser.	Direct observations	Hand sanitizer gel usage increased significantly during the intervention.	(+) Significant effect of the signs on hand-rub dispenser usage ($p<0.001$)

Abbreviations: OR: odds ratio, CI: confidence interval, RR: relative risk, (+) indicates a significant effect of the main intervention, (+/-) indicates both significant and not significant effects.

findings of this review is that nudging interventions such as messages, images, posters, visual cues, olfactory cues, directional arrows, footprints, handprints and accessibility have been effective in several settings. Yet, mixed results were also presented, especially regarding the gender-related content of the material, while the emotion-based content (i.e. a smiling emoticon) had a partial positive effect.

Most of the interventions, 12 out of 15, took place in the USA, Australia and European countries. This may reflect the politically liberal conditions in those countries. The liberal traditions in the USA, Australia and the European countries tend to favour nudging interventions in public health policy (Jones et al., 2014).

Nudging interventions that were effective used messages to communicate the risk of a possible infection, contained threatening messages, conveyed feelings of disgust, or stressed social norms, positive behaviours or feelings of comfort and well-being.

People have several reasons not to follow hand-washing both physical and mental (Pogrebna & Kharlamov, 2020; White et al., 2020). The barriers may be the lack of appropriate facilities (soap and water or hand sanitiser), lack of knowledge about the benefits of clean hands, overconfidence concerning their immune system response against pathogens and personal characteristics (gender, wealth and education) (Mobekk & Stokke, 2020; White et al., 2020). Whitby et al. (2006) identified that hand-washing was performed as two separate behaviours. Those practices are known as "inherent" and "elective". In "inherent" condition, hands are assumed as physically or emotionally dirty, so soap and water is required to keep hands clean. In "elective" condition, hands are not considered to be dirty and handwashing may not be performed in a particular circumstance. This perception makes the fight against COVID-19 more difficult, thus contributing to the transmission of the invisible pathogens that may exist on human hands.

Aunger et al. (2010) defined three psychological processes (reactive, motivated and cognitive processes) to explain handwashing behaviour. Reactive processes "triggered automatically by particular kinds of stimuli" (Aunger et al., 2010, p. 384) and become habitual. According to Pogrebna and Kharlamov (2020), the data on handwashing culture showed that at least 50% of people did not have a habit of automatic handwashing after using the toilet and there was a significant heterogeneity in handwashing habits around the world. People who do not follow any habitual hand hygiene behaviour tend to have a higher exposure to pathogens. Motivated is "a perceived discrepancy between an aspect of a person's current state and an ideal state" (Aunger et al., 2010, p. 384). Cognitive processes are "consciously determined plans to achieve a long-term goal" (Aunger et al., 2010, p. 384). Large scale and costly information campaigns that focused on educating people about the benefits of hand hygiene are examples of efforts to influence cognitive processes and failed to show measurable effects over long-term periods (Bischoff et al., 2000).

According to Rothman and Salovey (1997), health messages can be framed to emphasise either the advantages (gains) or consequences (losses) associated with a specific behaviour. Gain-framed messages

should be more influential for cases of prevention behaviours while loss-framed for cases of detection behaviours. The meta-analysis of Gallagher and Updegraff (2012) showed that positive message framing influenced preventive health behaviours. The study of Witte and Morrison (2000) showed that fear-inducing messages motivate protective behaviours when people believe they were able to act to prevent a threat. Botta et al. (2008) used threat messages to motivate hand-washing behaviours. The results of the included studies are in line with the existing literature on message framing.

All interventions in this review aimed to investigate the immediate effect of nudges in hand hygiene. Dreibelbis et al. (2016) and Grover et al. (2018) additionally studied their effect in the medium term and found that nudging interventions managed to maintain hand hygiene behaviour. However, there is no evidence, from this review, that nudges led to lasting behavioural changes in hand hygiene. Maintaining a habitual behaviour is probably the most challenging issue of improving preventive hygiene behaviours and of great importance to hand hygiene.

Nudging interventions that used images with old-aged male eyes increased hand hygiene. On the other hand, images with female eyes showed that it did not have the same effect (Gaube et al., 2018; King et al., 2016). These findings are consistent with previous studies that examined the effect of social influence by watching eyes and showed that old-aged male eyes were more influential than female eyes (Carli, 2001; Lau et al., 2023). Male eyes might create different feelings than female ones. Social role theory (Eagly & Wood, 2012) suggests that people have formed stereotypes and idealized roles in relation to power and dominance of genders. Males are associated with more powerful and dominant roles while females with lesser so power roles (Koenig et al., 2011; Krumhuber et al., 2022). This probably explains the specific findings. Additionally, the use of an image with a smiling emoticon had a positive effect on men while it had no effect on women (Blackwell, 2018). On the contrary, a sad emoticon had a positive effect on both men and women (Gaube et al., 2018). Emoticons could activate injunctive norms through instant feedback about the current status of hand hygiene of individuals (Schultz et al., 2007).

Using posters that combine images with targeted messages close to automatic or self-operated hand sanitiser devices had a direct and positive effect on the use of hand sanitiser gel or soap. Studies have shown that the usage of posters that acted as a reminder was effective for people who tend to forget to perform hygiene practices (Caris et al., 2018; Gaube et al., 2020). These findings are in line with previous results of Jenner et al. (2005). Disgust-inducing posters can trigger positive behaviour in people who believe that hand hygiene is not an important practice (Porzig-Drummond et al., 2009). These findings are consistent with previous interventions that included disgust concepts in hand hygiene (Curtis et al., 2001; Scott et al., 2007). The emotional concepts of dirtiness are closely related to disgust, which may influence people to clean their dirty hands (Whitby et al., 2006).

Interventions acted as reminders, the use of visual and olfactory cues, aimed at the action – reaction process. Automatic towel dispensers in the public restrooms of a university and the fresh smell of citrus in a hospital resulted in an immediate public reaction which led to an increase in the level of hand hygiene (Ford et al., 2014; King et al., 2016). An automatic towel dispenser that acted as a visual cue reduced the cognitive barriers to hand hygiene. A previous study on oculomotor behaviour showed the efficacy of visual cues as they are able to gain the necessary attention in a hand-washing environment and promote hand hygiene behaviours (Pelz & Canosa, 2001). According to the study of Holland et al. (2005), individuals were more likely to maintain their direct environment clean when exposed to olfactory cues.

Studies using simple floor markings leading to hand-washing facilities acting as a reminder or a cue have shown positive results. In these studies, footprints were used to guide primary school students from the toilets to the appropriate hand-washing facilities with soap and water (Dreibelbis et al., 2016; Grover et al., 2018). Similarly, directional arrows led college students from the toilets to the hand-washing sinks (Blackwell, 2018). Additionally, the attached image of a footprint on the pedal of a self-operated dispenser with hand sanitiser gel in a hospital had a direct effect and showed positive results (Wichaidit et al., 2020). Environmental cues, such as directional arrows and footprints, reduced the barriers and facilitated the access to hand hygiene infrastructures.

The use of hand gel was significantly increased by improvements in accessibility. The positioning of floor stands with hand sanitiser gel in prominent locations with an attached message based on social norms, increased hand hygiene behaviour (Aarestrup et al., 2016; Mobekk & Stokke, 2020). The intervention minimised the physical and cognitive barriers to hand hygiene as the centrally located floor stand with hand sanitiser indicated the availability of hand sanitising. The perception of convenience has been related to an increased level of hand hygiene and this might explain the result of the included studies (Whitby et al., 2007).

According to the meta-analyses of Hummel and Maedche (2019) and DellaVigna and Linos (2022), the median relative effect size of nudges was 21% and 33.5% respectively over the average baseline level. Conclusions based on direct comparison of these median rates with those reported in the papers included in this review are not safe to be drawn, as only two out of the fifteen studies (Blackwell, 2018; Gaube et al., 2020) reported lower effect sizes. Nevertheless, nudging interventions can be considered effective in relation to their low cost compared to other public health interventions such as costly national health campaigns that failed to show measurable effects in the long term (Bischoff et al., 2000).

4.1. *Strengths, limitations and further research*

This work presents strengths and weaknesses. The major strength is that it includes studies that use nudging interventions in hand hygiene in different countries, different settings and with different target groups. These studies cover a wide range of settings of human daily life activity, such as schools, universities, hospitals and other places where a large number of people gather. This review includes both hand-washing and hand sanitising behaviours under the general term “hand hygiene”.

One of the weak points of this work is the relatively limited number of articles related to nudges and hand hygiene that are currently available. The included articles do not provide any information to their participants about the appropriate way of washing hands with soap and water or the correct use of hand sanitiser gel, which is an important process and is related to the prevention of diseases.

The sustained presence of the researchers during direct observations in the study of Dreibelbis et al. (2016) and the potential reaction of some participants to the cameras in the study of Grover et al. (2018) have possibly affected participants’ behaviours. A recent research suggests that the Hawthorne effect can lead to overestimation of compliance in hand hygiene (Hagel et al., 2015).

There are several studies that used different indicators of hand hygiene compliance, such as the measuring of product volume and electronic monitoring sensors (Blackwell, 2018; Caris et al., 2018; Ford et al., 2014; Gaube et al., 2018, 2020; Judah et al., 2009; Pfattheicher et al., 2018; Porzig-Drummond et al., 2009). Measuring product use has some weaknesses, as the use of hand-washing or sanitising products does not necessarily reveal whether hand-washing or sanitising is actually being performed properly. Additionally, measuring the product volume use can be inaccurate in some cases (wasting or spilling product). On the other hand, monitoring the entrance of people in a hospital lobby, medical ward, public restrooms or in patients’ rooms has limitations. Electronic devices have their own biases since they lack the capacity to monitor more than one person at a time. Therefore, it is likely that some hand hygiene research results are missed when several people entered the facilities simultaneously. These kinds of measurements have a degree of uncertainty because of the limitations of the measuring instruments and the expertise of the experimenter making the measurements.

The articles showing a positive effect in hand hygiene may reflect a publication bias (Hopewell et al., 2009). The use of specific databases (PubMed, Google Scholar, Cochrane Library & Mendeley) and the exclusion of articles that were published in other languages other than English might be a selection bias.

The included articles did not provide instructions about the appropriate way of washing hands with soap and water or the correct use of hand sanitiser gel, which is an important process and is related to the prevention of diseases. Hand hygiene guidelines about the correct handwashing and hand sanitising techniques should be incorporated into future interventions to prevent pathogen transmissions. Additionally, none of the articles in this review recorded any reason why people did not follow a preventive hygiene behaviour. Future interventions should use – besides nudging techniques - explanatory theoretical models, like the Capability, Opportunity, Motivation – Behaviour (COM-B) model (Michie et al., 2011), so that they track specific components that possibly act as determinants of behaviour.

It could also be valuable for future studies to extend the critical discussion of the findings of this review in relation to public health policies in hand hygiene and the ethical challenges of nudges. Nudging has been criticised for the soft-governance techniques that rely on individualised, behaviouristic, and paternalistic interventions to promote specific behaviours while ignoring the role of social determinants of health and material inequalities (Ewert, 2017; Mulderrig, 2019; Wilkins, 2013).

5. Conclusion

The present systematic review showed that nudging interventions such as messages, images, posters, visual cues, olfactory, environmental cues and increased ease of access had positive effects on hand hygiene in several settings. Nudging interventions can be considered as an additional public health tool to promote hand hygiene behaviour in daily life. Nudges provide great opportunities to improve the design of hand hygiene behaviour change campaigns, as they may produce immediate behavioural changes that are the key factors against the spread of COVID-19.

Nudges should be included in the existing and future public health interventions to prevent the spread of COVID-19 and future pandemics, simply and cost-effectively, rather than being an alternative and unconventional tool for public health policies.

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Declaration of Competing Interest

The authors declare that they have no conflict of interest.

Data availability

Data will be made available on request.

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** The references included in the systematic review are marked with an asterisk*

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