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Smartphones' impact on nursing performances: a cross-sectional multicenter study

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Keywords: Personal communication devices; smartphone; nursing performance; electronic distraction; nurses; work interruption; medical staff and/or hospitals; cellular phone

Parole chiave: Strumenti di comunicazione personale; smartphone; performance infermieristica; distrazione elettronica; infermieri; interruzione

Abstract

Background. *In recent years, the technology world has significantly shaped society. This study aims to survey the views of registered nurses with hospital working experience regarding the personal communication devices use impact in hospital units. The secondary outcome of this study was to identify differences in mobile device use based on demographic and organizational factors.*

Study design. *Cross-sectional study by survey.*

Methods. *The questionnaire comprises 22 items divided into four sections. Overall 778 questionnaires were included in the study, 329 questionnaires were collected on pen-and-paper, whereas 449 by an online survey.*

Results. *Findings showed that smartphones have a different impact on performance, utilization and impact scale according to gender, age and educational attainment. Generally males using more frequently personal communication devices for non-work-related activities affected negatively their working performance by respect to females. Moreover, younger nurses report being more distracted by using smartphones for non-work-related activities than older nurses. At the same time, younger nurses believe that smartphones may lead to an improvement in patient care skills. Nurses with fewer years of service (1 month - 10 years) report being more distracted by non-work-related activities on their smartphones than nurses with more years of service (>20 years).*

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Conclusions. *The smartphone is a potential distraction source. The most exposed groups are the younger nurses' and those with little work experience, and both groups (young age, less experience) can be considered factors for potential distraction.*

Introduction

In the last few years, the technology world has significantly re-shaped the society. Regardless of social conditions and age, most people own an electronic device, a smartphone, tablet or personal computer. It is the easiest and fastest mode of communication that allows the transmission of news instantly, using the Internet, messaging services or e-mail. These means of communication are also used in the health sector to support professionals in research, clinical activity and health education (1, 2).

A recent literature review has shown the smartphone use benefits in clinical practice: enhanced interprofessional communication; easy and quick access to clinical information; improved time management, and reduced work stress. At the same time, smartphone use is associated with many disadvantages: distraction from work and the appearance of unprofessionalism (3).

One study conducted by Schmenner et al. (4) demonstrated how age could affect mobile devices use: younger nurses seem more likely to use them, while older age professionals tend to be reluctant. An investigation conducted in Germany by Whitlow et al. (5), highlighted that 63% of the nurses who answered the questionnaire say they use the smartphone for purely personal purposes and that it can also improve communications between the multidisciplinary team, thus replacing the use of the pager (6). The smartphone is used by nurses in order to communicate with each other, to seek information and to document anything (7-10). Technologies provided by hospitals to healthcare workers should be used only for work purposes. However, many of these were deemed "unreliable and inferior compared to the personal smartphones that nurses have". Consequently, nurses frequently use their personal smartphones for work purposes (11). Different studies indicate that nurses use their smartphones for work purposes to enhance productivity (9, 10, 12).

Despite this, using the smartphone during nursing activities could cause distraction and possible errors with negative consequences on patient safety (13-15). Moreover, smartphones use could lead to several concerns about security and personal use (16). Distractions could lead nurses to make errors, such as medication errors, which are considered a serious public health problem (17-23). In 2015 McBride (13, 14) conducted a conceptual analysis to define the concept of distraction from smartphones and other mobile devices in hospitals (24, 25). McBride defines distraction as "*an interruption of a clinical care activity caused by internal or external stimuli to the individual. The source of distraction could come externally from another person, such as another doctor or patient, through a mechanical stimulus, such as a telephone ring or a call light, or an alarm triggered by a machine, such as that of the infusion pump*" (13,14). She characterises distractions due to "internal causes" as interruptions of the thought process or intrusive thoughts unrelated to the main task (26).

Leroy et al. (27) have shown that "*completing tasks without interruptions has become a luxury*" for today's employees. Interruptions in care provision are associated with procedural failures and errors (28,29).

Therefore not all studies agree about smartphone use during nurses' shift work. Undoubtedly is considered an important instrument supporting nurses' activities, but also the use could affect caring and patient safety (30-32). Therefore the heterogeneity of the experiences found in clinical practice and research suggests the need for further studies to highlight the impact of smartphone use in nursing care.

This study aimed to explore nurses' opinions and the impact of the use of the smartphone during the work shift and how this can affect caring activities.

Based on the Unified Theory of Acceptance and Use of Technology (UTAUT) (33), the secondary outcome of this study was to identify the differences in the mobile use devices between groups based on demographic and organizational factors.

Methods

1. Study design

This study used a cross-sectional survey design. The study reporting was made and supported under the STROBE guidelines' and checklist (34) (TAB S1).

2. Study procedures

The questionnaire was administered both online, using the Google Form platform, and on paper. A dual mode of administration was chosen in order to reach the largest number of respondents. Data collection took place from January to May 2019. A convenience sample was recruited. All nurses who received the invitation to participate in the study were practicing in hospitals. Participation in the study was voluntary and anonymous. In the event of missing data from paper questionnaires, it was not included in the sample. On the contrary, all items were set up as mandatory for the web surveys.

3. Study population

A convenience sample was recruited. Nurses had to meet the following inclusion criteria: working in hospital settings providing care for the patient; having at least one year's work experience in clinical ward; willingness to participate in the study; knowledge and understanding of the Italian language. Exclusion criteria were students or other healthcare professionals or manager or head nurses.

4. Instruments

In 2013, McBride et al. (24) developed and validated a questionnaire to detect nurses' opinions regarding the impact of personal communication devices on patient care in a hospital setting: the Nurses' Use of Personal Communication Devices Questionnaire.

In 2014 (25), the questionnaire was further reduced to 32 items: 14 on the use for personal purposes during working hours, 9 on how the smartphone use can affect care performance, 6 related to smartphone use for communication between the members of the hospital team, and the last 3 items investigate nurses and patients opinion on smartphone use during treatment activities. The structuring of the responses uses three different forms of a 4-option Likert scale. 74% of the answers given in both questionnaires were the same, and the concordance analysis between the two versions, carried out through Cohen's K statistical test, generated values between .67 - .57, demonstrating internal reliability of the tool. Reliability of each of the four sections was also assessed, excluding the one relating to personal data, by calculating Cronbach's Alpha.

Di Muzio et al. adapted this questionnaire to the Italian context (35). Of the original 32 items, 16 were retained, and a further 6 on the socio-demographic data were added, for a total of 22 items. The final questionnaire is divided into 4 sections: demographic data, performance, use and impact.

The demographic section, made by 6 items collecting data relating to age, gender, professional qualifications achieved, post-basic qualifications, years of working experience and the care setting of reference.

The second and third sections (performance and use), made by 12 items, investigating smartphone use during the work shift and caring activities may be affected; the answers are structured with a 4-point Likert scale (never, once per shift, from 2 to 5 times per shift, more than five times per shift).

The last section (impact) consists of 4 items evaluating the opinion on smartphone use with a 4-point Likert scale (totally disagree, disagree, agree, totally agree). Italian version of the instrument reported a high internal consistency (from 0.749 to 0.799), however slightly lower than that of the original version (from 0.84 to 0.96) (24). The value of the KMO test was 0.784, and the Bartlett sphericity test was significant ($\chi 2 = 1042.782$, df = 120, $p < 0.001$), indicating that the analysis of the data factors is appropriate (31).

The instrument was submitted for exploratory factor analysis (31). In the results four factors emerged: demographics, performance, use, and impact of smartphones. In Di Muzio et al's study, KMO test was 0.821, and the Bartlett sphericity test was significant ($\chi 2 = 3299,632$, df = 120, $p < 0.001$). The instrument's reliability, measured through Cronbach's Alpha, was 0.78.

5. Ethics

Ethics Committee approval for the study and questionnaire administration was achieved before data collection (Prot. N. 1188/17). All participated voluntarily, were informed about the study aims and procedures, and about their right to participate or withdraw at any time. All participants signed informed consent. Those who filled the paper informed consent submitted it in a single closed envelope to the research center. For those who participated in online survey, participation to the study was considered as an expression of consensus. Also a unique identification

code for each participant was provided in order to guarantee data protection and anonymity.

6. Statistical analysis

Data obtained from the questionnaire administration was displayed on an Excel worksheet and associated with alphanumeric variables to identify questions and responses. Subsequently, the statistical analysis of the variables was carried out by *IBM SPSS Statistics version 25*. The descriptive analysis of all examined variables was performed using absolute frequencies and percentages. The analysis of variance (ANOVA) was subsequently carried out by inferential statistics technique, allowing hypotheses verification relating to differences between two or more populations means. Therefore, it allows the study of two or more data groups by comparing internal variability and between the groups. The variance homogeneity was verified through the Levene test, which represented the substrate for reading the results. The test verifies the null hypothesis that the error variance of dependent variables is equal between the groups; if Levene's statistic is significant at the 0.05 level, the null hypothesis that the groups have the same variance is rejected.

Results

1. Professional and socio-demographic characteristics of the sample

778 Italian registered nurses working in Italian hospitals completed a self-administered questionnaire. *Table 1* shows nursing sample demographic and professional characteristics; 26.5% (n = 206) male, and 73.5% (n = 572) female; 38.6% (n = 300) were ≥41 years of age, 23.1% (n = 180) between 31-40, the mean being 36 years old, 5% (n = 284) were aged between 20-30; 14 (1.8%) did not declare their age.

The majority, 70.1% (n = 545), obtained a university degree (Degree or university diploma), while the remaining 29.8% (n = 232) obtained a non-university degree. Concerning post-basic qualifications, 26.6% (n = 207) stated having graduated with a Master's degree, and 36.1% (n = 281) had attended "Other". 49.2% (n = 383) reported having length of service between 1 month and 10 years, 24.2% (n = 188) between 10 and 20 years and 26.5 % (n = 206) over 20 years. About work setting, 22.1% (n = 172) work in Medicine, 24.4% (n = 190) in Surgery, 25.3% (n = 197) in a Critical / Emergency Area, 5.9% (n = 46) in a Pediatric Area and 21.6% (n = 168) in "Other – outpatient department".

Table 1 - Demographic and personal characteristics of the responding nurses

Variables	N (%)
Age, years	
< 30	284 (36.5)
31 – 40	180 (23.1)
41 – 50	300 (38.6)
Missing values	14 (1.8)
Gender	
Male	206 (26.5)
Female	572 (73.5)
Educational qualification	
University degree in nursing	545 (70.1)
Non-university qualification	232 (29.8)
Postgraduate training courses	
Courses not specified	135 (17.4)
Master's degree	104 (13.4)
Master courses	207 (26.6)
Other (Ph.D.)	281 (36.1)
Years of work	
1 – 10	383 (49.2)
11 – 20	188 (24.2)
>21	206 (26.5)
Workplace setting	
Medical Ward	172 (22.1)
Surgical Ward	190 (24.4)
Intensive Care Unit	197 (25.3)
Pediatric Ward	46 (5.9)
Other (outpatient department).	168 (21.6)

2. Descriptive statistics on the performance scale

The sample's responses allow us to deduce the smartphones impact on work performance. Most of the sample (n = 394, 50.6%) answered that using the smartphone for non-work related activities never distracted them from their clinical care activity, and 78.9% (n = 614) answered that it has never negatively affected their work performance. Despite this, 65.8% (n = 508) agreed that using the smartphone for unrelated activities has never helped the individual to be more concentrated during the assistance activities. 41.9% (n = 326) believe its use improved clinical-care activity once per shift. Only 269 respondents (34.9%) claimed to have seen another colleague using the smartphone 2-5 times per shift.

3. Descriptive statistics on the utilization scale

The sample's responses allow us to evaluate the use and related reasons for smartphone use during the work shift. Most respondents say they used the smartphone for business purposes:

- to access the Health App (n = 530, 68.3%) only once per shift;
- to consult procedures, protocols or guidelines (n = 362, 46.6%) only once per shift using the smartphone;
- to obtain information on drugs (n = 344, 44.2%) only once per shift;
- as a calculator (calculations / dosages) (n = 305, 39.3%) only once per shift. Only 37.8% (n = 292) say they have never used a smartphone to communicate with other care team members.

Regarding the use for non-working purposes, most responders (n = 348, 44.8%) claim to have used the smartphone only once per shift to send / check personal messages via e-mail and / or social networks (Facebook, WhatsApp, Twitter), and 40.2% (n = 312) to surf the Internet.

4. Descriptive statistics on the impact scale

The sample's responses allow the individual opinions evaluation on smartphone use during daily practice. Most responders (n = 393, 50.5%) agree that smartphone use encourages communication between team care members in order to improve the quality of care. 44.7% (n = 348) disagree that smartphone use improves patient safety, and 43.2% (n = 336) disagree about smartphone potential to reduce stress related to work and be an incentive for patient care. Most respondents (n = 365, 47%) agree that smartphone use increases the probability of making a mistake.

5. Differences in performance, utilization and impact scale according to sex

Table 2 shows the performance, utilization and impact scale differences according to sex. The t-test results showed that males, more than females, using personal communication devices for non-work-related activities, say it has negatively affected their work performance (t=3,358; p<0,001). At the same time, using personal communication devices at work for non-work-related activities improves their ability to focus on their work (t=3,077; p<0,001).

According to the utilization scale, females use personal communication devices to access work drug references more frequently than males (t=-,766; p<0,001), while males use personal communication devices to call or send messages to family or friends (t=2,218; p<0,001) or to post on social networking sites (t=4,108; p<0,05) more frequently than females.

6. Differences in performance, utilization and impact scale according to age

It was assessed whether smartphone use has a different impact on individual performance within the three age groups (20- 30 years; 31-40 years; 41 years onwards). The ANOVA analysis revealed significance in several variables. The post-hoc analysis, therefore, allowed the following deductions to be drawn (Table 3).

Younger nurses report being more distracted from using the smartphone for non-work-related activities than older nurses (F(2,759)=4.902, p<0,001). At the same time, they believe that smartphones use promotes their care skills improvement (F(2,760)=12.702, p<0,01).

Older nurses use smartphone less than younger nurses, both for work, such as obtaining information on drugs (F(2,761)=14.93, p<0,01) and as a calculator for calculations / dosages (F(2,759)=14.60, p<0,01), and for non-work activities during the shift, such as checking / sending personal messages via e-mail and / or social networks (F(2,760)=32,40, p<0,01) and for surfing the Internet (F(2,759)= 23,117, p<0,01).

In addition, older nurses believe less in using the smartphone to improve patient safety (F(2,758)= 7,790, p<0,01). Nurses in the middle age group (31-40 years) use the smartphone more during working hours to communicate with other members of the care team than the very young (20-30 years) (F(2,758)= 10,65, p<0,01). They also believe that the use of the smartphone during work does not increase the probability of making mistakes compared to the very young (20-30 years) and the elderly (41 years onwards) (F(2,759)= 3,889, p<0,05).

7. Differences in performance, utilization and impact scale according to Educational Attainment

Educational attainment refers to education qualifications (non-university or university degrees). The t-test results (Table 4) showed that responders with a non-university degree using personal communication devices for non-working related activities perceived a negative impact on working performance compared to responders with a bachelor's degree in nursing (t=1,028; p<0,05).

Moreover, the t-test results showed that those with bachelor's degrees in nursing find advantages in personal communication devices use in terms of

Table 2 - Differences according to Sex (T Test Results)

Variables	Code[a]	N (% total)	n (% in sex)		T test Results [mean (SD)]			
			Male	Female	Male	Female	t	p
Performance 3	0	614 (79.2)	147 (71.4)	467 (82.1)	.36 (.638)	.21 (.495)	3.358	.001
	1	133 (17.2)	47 (22.8)	86 (15.1)				
	2	22 (2.8)	9 (4.4)	13 (2.3)				
	3	6 (0.8)	3 (1.5)	3 (0.5)				
Performance 4	0	508 (65.8)	121 (58.7)	387 (68.4)	.59 (.814)	.41 (.677)	3.077	.001
	1	192 (24.9)	56 (27.2)	136 (24.0)				
	2	56 (7.3)	22 (10.7)	34 (6.0)				
	3	16 (2.1)	7 (3.4)	9 (1.6)				
Utilization 1	0	82 (10.5)	32 (15.5)	50 (8.7)	1.40 (.898)	1.45 (.755)	-.766	.001
	1	344 (44.2)	86 (41.7)	258 (45.1)				
	2	284 (36.5)	62 (30.1)	222 (38.8)				
	3	68 (8.7)	26 (12.6)	42 (7.3)				
Utilization 3	0	257 (33.1)	84 (40.8)	173 (30.3)	.84 (.864)	.94 (.785)	-1.435	.006
	1	362 (46.6)	81 (39.3)	281 (49.2)				
	2	126 (16.2)	30 (14.6)	96 (16.8)				
	3	32 (4.1)	11 (5.3)	21 (3.7)				
Utilization 6	0	205 (26.4)	54 (26.2)	151 (26.4)	1.20 (.946)	1.05 (.826)	2.218	.000
	1	348 (44.8)	271 (47.5)	77 (37.4)				
	2	173 (22.3)	54 (26.2)	119 (20.8)				
	3	51 (6.6)	21 (10.2)	30 (5.3)				
Utilization 7	0	284 (36.6)	63 (30.6)	221 (38.8)	1.13 (.966)	.84 (.818)	4.108	.002
	1	312 (40.2)	74 (35.9)	238 (41.8)				
	2	138 (17.8)	48 (23.3)	90 (15.8)				
	3	42 (5.4)	21 (10.2)	21 (10.2)				
Impact 4	0	41 (5.3)	18 (8.7)	23 (4.0)	1.77 (.907)	1.80 (.763)	-.505	.000
	1	225 (29)	60 (29.1)	165 (28.9)				
	2	365 (47)	80 (38.8)	285 (50)				
	3	145 (18.7)	48 (23.3)	97 (17.0)				

[a] code = 0: never, 1 once per shift; 2: 2-5 times per shift; 3: > 5 times per shift

Performance 1: The use of my personal communication device for non-work related activities has distracted me while working
Performance 2: The use of my personal communication device improve my performance while working
Performance 3: The use of my personal communication device for non-work related activities has negatively effected my performance while working
Performance 4: Personal communication device use at work for non-work related activities improves my ability to focus on my work
Performance 5: I have witnessed another nurse whose personal communication device use was negatively effecting his/her performance while working

Utilization 1: I access work drug references
Utilization 2: I use the device as a calculator for nursing/medical formulas
Utilization 3: I access work-related protocols/guide lines
Utilization 4: I access work-related Health Apps that assist my patient care
Utilization 5: I call or check/send work related text messages or emails to other members of the healthcare team
Utilization 6: I call or check/send text messages or emails to family or friends (Facebook, Whatsapp, Twitter, etc.)
Utilization 7: I check/post on social networking sites

Impact 1: Does the use of personal communication device promote communication between the members of the care team?
Impact 2: Does Personal communication device use improve patient safety?
Impact 3: Does Personal communication device use reduce work-related stress?
Impact 4: Does Personal communication device use increase medical errors while working?

Table 3 - Differences according to Age (ANOVA Results)

Variables	Age: mean (SD)			F	p
	< 30 years (n=284)	31 – 40 (n=180)	41 – 50 (n=300)		
Performance Scale					
Performance 1	.74 (.794)	.78 (.829)	.57 (.810)	4.902	.008
Performance 2	1.24 (.785)	1.22 (.841)	.86 (.840)	18.89	.000
Performance 4	.45 (.685)	.62 (.806)	.36 (.689)	7.484	.001
Performance 5	1.98 (.908)	2.12 (.899)	1.86 (1.006)	4.110	.017
Utilization Scale					
Utilization 1	1.67 (0.706)	1.45 (0.734)	1.21 (0.843)	25.247	.000
Utilization 2	1.45 (0.866)	1.41 (0.895)	1.03 (0.906)	18.491	.000
Utilization 3	1.04 (0.744)	0.92 (0.855)	0.8 (0.822)	6.311	.002
Utilization 5	0.84 (0.832)	1.08 (0.878)	0.91 (0.894)	4.385	.013
Utilization 6	1.26 (0.866)	1.33 (0.839)	0.8 (0.783)	32.408	.000
Utilization 7	1.14 (0.893)	1.01 (0.825)	0.67 (0.803)	23.117	.000
Impact Scale					
Impact 1	1.59 (0.786)	1.64 (0.829)	1.33 (0.855)	10.652	.000
Impact 2	1.28 (0.701)	1.34 (0.735)	1.09 (0.764)	7.790	.000
Impact 3	1.37 (0.793)	1.43 (0.762)	1.07 (0.759)	16.308	.000
Impact 4	1.83 (0.769)	1.65 (0.773)	1.85 (0.847)	3.889	.021

Performance 1: The use of my personal communication device for non-work related activities has distracted me while working
Performance 2: The use of my personal communication device improve my performance while working
Performance 3: The use of my personal communication device for non-work related activities has negatively effected my performance while working
Performance 4: Personal communication device use at work for non-work related activities improves my ability to focus on my work
Performance 5: I have witnessed another nurse whose personal communication device use was negatively effecting his/her performance while working

Utilization 1: I access work drug references
Utilization 2: I use the device as a calculator for nursing/medical formulas
Utilization 3: I access work-related protocols/guide lines
Utilization 4: I access work-related Health Apps that assist my patient care
Utilization 5: I call or check/send work related text messages or emails to other members of the healthcare team
Utilization 6: I call or check/send text messages or emails to family or friends (Facebook, Whatsapp, Twitter, etc.)
Utilization 7: I check/post on social networking sites

Impact 1: Does the use of personal communication device promote communication between the members of the care team?
Impact 2: Does Personal communication device use improve patient safety?
Impact 3: Does Personal communication device use reduce work-related stress?
Impact 4: Does Personal communication device use increase medical errors while working?

"ability to focus on work" (t=2,174; p<0,001) and stress prevention (t=4,404; p<0,001). Accordingly, responders with a bachelor's degree in nursing use personal communication devices more frequently to access work-related Health Apps than non-university (t=1,345; p<0,05).

8. Differences in performance, utilization and impact scale according to working experience

It was assessed whether smartphone use has a different impact between the three service seniority groups (1 month-10 years, 10 years-20 years, over 20 years).

ANOVA analysis revealed significance in several variables. Therefore post-hoc analysis allowed the following deductions to be drawn (Table 5).

Nurses with fewer service years (1 month-10 years) report being more distracted by using smartphone for non-work-related activities than nurses with greater experience (> 20 years) (F(2,773)=3.878, p<0,05). Also, they believe that smartphone use favours their care skills improvement (F(2,771)=26.461, p <0.01) compared to the other two categories (10-20 years and> 20 years).

Nurses with fewer years of service (1 month-10 years) report they use their smartphone to

obtain information on drugs ($F(2,774)=32.97$, $p<0.01$), as a calculator for calculations / dosages ($F(2,773)=23.179$, $p<0.01$), and to consult procedures and guidelines ($F(2,773)=23.179$, $p<0.01$). They also believe in improving security through technology ($F(2,771)=11.056$, $p<0.01$). Nurses with more years of service use the smartphone less to check / send personal messages via e-mail and / or social networks (Facebook, WhatsApp, Twitter...) compared to other categories (1 month-10 years and 10-20 years) ($p<0.01$).

Discussion and conclusions

This study aimed to investigate the smartphone use during care practice, quantifing how different groups used smartphones according to demographic characteristics. This research findings may add to the current knowledge on smartphone use. Concerning the smartphone use for work-related activities, it was highlighted that the most common use is access to the Health App (applications aimed at the care and assistance of patients) followed by procedures, protocols or guidelines consultation. Most nurses believe that smartphone use limited to once per shift favours care skills improvement and agrees that smartphones use encourages communication between care team members, improving the quality of care. These findings are most common in younger registered nurses. Also, Bautista (7) showed that the most common smartphones use is related to healthcare team communication. Indeed, smartphone communication between team members is one of the favourable aspects of this device. Even if smartphones had several advantages (36,37), some studies focus on the risk that PCDs may be used to transmit pathogens: a recent literature review viewed smartphones as a bacterial reservoir in healthcare settings (38, 39).

Table 4 - Differences according to Education Attainment (T Test Results)

Variables	Education qualification: mean (SD)			
	Non-university degree	University degree	t	p
Performance Scale				
Performance 3	.28 (599)	.24 (.500)	1.028	.032
Performance 4	.37 (.653)	.49 (.736)	-2.174	.001
Performance 5	1.81 (.995)	2.02 (.925)	-2.797	.049
Utilization Scale				
Utilization 3	.76 (.791)	.98 (.805)	-3.465	.037
Utilization 4	.36 (.624)	.44 (.705)	-1.345	.006
Impact Scale				
Impact 3	1.07 (.753)	1.34 (.790)	-4.404	.000

Performance 1: The use of my personal communication device for non-work related activities has distracted me while working
Performance 2: The use of my personal communication device improve my performance while working
Performance 3: The use of my personal communication device for non-work related activities has negatively effected my performance while working
Performance 4: Personal communication device use at work for non-work related activities improves my ability to focus on my work
Performance 5: I have witnessed another nurse whose personal communication device use was negatively effecting his/her performance while working

Utilization 1: I access work drug references
Utilization 2: I use the device as a calculator for nursing/medical formulas
Utilization 3: I access work-related protocols/guide lines
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Utilization 6: I call or check/send text messages or emails to family or friends (Facebook, Whatsapp, Twitter, etc.)
Utilization 7: I check/post on social networking sites

Impact 1: Does the use of personal communication device promote communication between the members of the care team?
Impact 2: Does Personal communication device use improve patient safety?
Impact 3: Does Personal communication device use reduce work-related stress?
Impact 4: Does Personal communication device use increase medical errors while working?

Table 5 - Differences according to Working experience (ANOVA Results)

Variables	Working experience (years)			F	p
	1 to 10 years	11 to 20 years	more than 21		
Performance Scale					
Performance 1	.74 (.809)	.70 (.793)	.70 (.793)	3.878	.021
Performance 2	1.29 (.794)	.97 (.827)	.80 (.827)	26.461	.000
Performance 4	.51 (.735)	.48 (.777)	.33 (.616)	4.688	.009
Utilization Scale					
Utilization 1	1.66 (.701)	1.23 (.793)	1.20 (.846)	32.977	.000
Utilization 2	1.49 (.865)	1.18 (.925)	.99 (.883)	23.179	.000
Utilization 3	1.07 (.794)	.75 (.757)	.77 (.821)	14.792	.000
Utilization 6	1.24 (.860)	1.13 (.898)	.77 (.740)	21.323	.000
Utilization 7	1.09 (.861)	.86 (.897)	.66 (.786)	17.659	.000
Impact Scale					
Impact 1	1.63 (.796)	1.41 (.839)	1.32 (.851)	11.056	.000
Impact 2	1.33 (.710)	1.12 (.758)	1.11 (.759)	8.314	.000
Impact 3	1.40 (.795)	1.26 (.759)	1.02 (.746)	15.427	.000

Performance 1: The use of my personal communication device for non-work related activities has distracted me while working
Performance 2: The use of my personal communication device improve my performance while working
Performance 3: The use of my personal communication device for non-work related activities has negatively effected my performance while working
Performance 4: Personal communication device use at work for non-work related activities improves my ability to focus on my work
Performance 5: I have witnessed another nurse whose personal communication device use was negatively effecting his/her performance while working

Utilization 1: I access work drug references
Utilization 2: I use the device as a calculator for nursing/medical formulas
Utilization 3: I access work-related protocols/guide lines
Utilization 4: I access work-related Health Apps that assist my patient care
Utilization 5: I call or check/send work related text messages or emails to other members of the healthcare team
Utilization 6: I call or check/send text messages or emails to family or friends (Facebook, Whatsapp, Twitter, etc.)
Utilization 7: I check/post on social networking sites

Impact 1: Does the use of personal communication device promote communication between the members of the care team?
Impact 2: Does Personal communication device use improve patient safety?
Impact 3: Does Personal communication device use reduce work-related stress?
Impact 4: Does Personal communication device use increase medical errors while working?

Regarding the use not related to work, the most frequent activity is sending/checking personal messages via e-mail and / or social networks (Facebook, WhatsApp, Twitter), allowing nurses to remain in contact with the outside environment during working hours, in accordance with the study of Bautista et al. (11). Differences according to sex were shown evident, with males accessing social media more frequently than females. These results must be interpreted cautiously and not generalised, as the male responders sample was smaller than females one. However, this aspect could be inquired by future research. Indeed, to the authors' knowledge, no specific studies about gender influence on nurses' smartphones use were conducted. Conversely, many studies addressed this phenomenon among young people, highlighting gender differences in smartphone use (40-42).

Other studies showed that nurses use smartphones primarily to send and receive messages (8,9,13,43). Our results show that nurses frequently use their smartphones to send voice or text messages, as supported by Bautista et al. (7). The majority of respondents disagreed that nurses could use the smartphone as a tool to improve patient safety and reduce stress related to work.

On the contrary, some studies argue that mobile devices can positively influence concentration and work performance as they reduce work-related stress (43). Although most nurses reported that smartphone use does not adversely affect performance or cause distraction, respondents also believe that using the smartphone could increase the probability of making mistakes. Distraction is a significant risk that can adversely affect patient safety (44,45); distraction is the cause of "inappropriate registration" (56.2%) or "inappropriate measurement of vital signs".(33.7%), as reported by Pucciarelli et al. (43).

This study has some limitations. First, participants come primarily from central Italy (more than 70%), which is partially representative of the Italian nursing population. Also gender subgroups show large difference in terms of sample size. Regarding the participants age, authors could not collect informed consent from any nurses over the age of 50. Therefore it would be interesting to continue this study by including a larger population with respect to age and different subgroups. Only professional nurses were involved in this investigation, excluding health professionals such as physiotherapists, midwives, doctors, pharmacists, etc. As many different health professionals perform patient care, future research involving different health professionals will allow a global view on wether smartphones act as a distraction, and how musc this affects patient care.

Furthermore, no specific analysis to define the sample size was conducted, imposing caution and prudence in using and generalizing the results. The questionnaire was administered using a dual-modality, both on paper and online, using a Google Form®, which reaches, as noted above, a wider reference population but does not allow access to data on non-response and adherence to the study. As it is a self-report scale, it is necessary to weigh the reliability of the answers.

Undoubtly the results show that respondents believe that smartphone use can lead to distractions. The most exposed categories were younger nurses and those with little working experience. Also this study provides ideas for further investigations on smartphone distraction in hospitals and territorial contexts. Although this research adds to current knowledge by providing the results of a survey of a large sample of nurses about their perceptions of smartphone use, using smartphones during acute care remains controversial. The results of this research add to the current state of science with a more objective approach that can still argue that smartphone use could be perceived as a source of distraction.

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Riassunto

Impiego degli smartphones e Performance degli infermieri: uno studio multicentrico

Background. Negli anni recenti, il mondo della tecnologia ha significativamente rimodellato la società. Questo studio desidera monitorare le opinioni degli infermieri che lavorano in ospedale riguardo l'impatto dei mezzi di comunicazione individuali nelle unità ospedaliere. Secondariamente l'identificazione delle differenze nell'uso dei telefonini basato sui fattori demografici ed organizzativi.

Disegno dello studio. Studio trasversale.

Metodi. Il questionario comprende 22 elementi divisi in quattro sezioni. Mediante un sondaggio sono stati raccolti 329 questionari cartacei e 449 on-line, per un totale di 778 questionari.

Risultati. I dati hanno evidenziato come gli smartphones abbiano un differente impatto sulla performance, rispetto al genere, l'età ed il titolo scolastico. Gli uomini che utilizzano i telefonini per attività non correlate al lavoro hanno influenzato negativamente la loro performance sul lavoro rispetto alle donne. Inoltre, gli infermieri più giovani riportano essere più distratti dall'utilizzo dei telefonini per attività non correlate al lavoro rispetto ai colleghi più anziani. Al tempo stesso, gli infermieri più giovani ritengono che i telefonini possano consentire un miglioramento nelle competenze per l'assistenza dei pazienti. Gli infermieri con minore esperienza lavorativa (≤10 anni) riferiscono di essere più distratti dalle attività non correlate al lavoro sui loro telefonini rispetto ai colleghi più anziani (>20 anni).

Conclusioni. Il telefonino costituisce una potenziale fonte di distrazione. Il gruppo più esposto è rappresentato dagli infermeri più giovani e quelli con minore esperienza lavorativa, ed entrambi i gruppi (giovane età, minore esperienza) possono essere considerati potenziali fattori di distrazione.

References

1. Krick T, Huter K, Domhoff D, Schmidt A, Rothgang H, Wolf-Ostermann K. Digital technology and nursing care: a scoping review on acceptance, effectiveness and efficiency studies of informal and formal care technologies. BMC Health Serv Res. 2019 Jun 20; **19**(1): 400. doi: 10.1186/s12913-019-4238-3.

2. Kim JH, Park H. Effects of Smartphone-Based Mobile Learning in Nursing Education: A Systematic Review and Meta-analysis. Asian Nurs Res (Korean Soc Nurs Sci). 2019 Feb; **13**(1): 20-9. doi: 10.1016/j.anr.2019.01.005. Epub 2019 Jan 16.
3. Oh YS, Yeon JJ, Ens TA, Mannion CA. A Review of the Effect of Nurses' Use of Smartphone to Improve Patient Care. JURA. 2017; **6**: 32-9.
4. Schmeer R, Behrends M, Kupka T, Meyenburg-Altwarg I, Marschollek M. Use and Acceptance of Mobile Technology by Hospital Nurses in Germany. Stud Health Technol Inform. 2016; **225**: 944-5.
5. Whitlow ML, Drake E, Tullmann D, Hoke G, Barth D. Bringing technology to the bedside: using smartphones to improve interprofessional communication. Comput Inform Nurs. 2014; **32**(7): 305-11. doi: 10.1097/CIN.0000000000000063.
6. Farrell M. Use of iPhones by Nurses in an Acute Care Setting to Improve Communication and Decision-Making Processes: Qualitative Analysis of Nurses' Perspectives on iPhone Use. JMIR Mhealth Uhealth. 2016 May; **4**(2): e43. doi: 10.2196/mhealth.5071.
7. Bautista JR. Filipino Nurses' Use of Smartphones in Clinical Settings. Comput Inform Nurs. 2019 Feb; **37**(2): 80-9. doi: 10.1097/CIN.0000000000000482.
8. Bautista JR, Lin TTC. Nurses' use of mobile instant messaging applications: A uses and gratifications perspective. Int J Nurs Pract. 2017 Oct; **23**(5). doi: 10.1111/ijn.12577. Epub 2017 Jul 28.
9. Bautista JR, Rosenthal S, Lin TT, Theng YL. Psychometric evaluation of the Smartphone for Clinical Work Scale to measure nurses' use of smartphones for work purposes. J Am Med Inform Assoc. 2018 Aug 1; **25**(8): 1018-25. doi: 10.1093/jamia/ocy044.
10. Bautista JR, Rosenthal S, Lin TT, Theng YL. Predictors and outcomes of nurses' use of smartphones for work purposes. Computers in Human Behavior. 2018 Jul; **84**: 360-374. doi: 10.1016/j.chb.2018.03.008.
11. Bautista JR, Lin TTC, Theng YL. Influence of Organizational Issues on Nurse Administrators' Support to Staff Nurses' Use of Smartphones for Work Purposes in the Philippines: Focus Group Study. JMIR Nurs. 2020 Jan 10; **3**(1): e17040. doi: 10.2196/17040.
12. Bautista JR, Lin TT. Sociotechnical analysis of nurses' use of personal mobile phones at work. Int J Med Inform. 2016 Nov; **95**: 71-80. doi: 10.1016/j.ijmedinf.2016.09.002. Epub 2016 Sep 16.
13. McBride DL. Distraction of clinicians by smartphones in hospitals: a concept analysis. J Adv Nurs. 2015 Sep; **71**(9): 2020-30. doi: 10.1111/jan.12674. Epub 2015 Apr 21.
14. McBride DL, LeVasseur SA, Li D. Non-work-related use of personal mobile phones by hospital registered nurses. JMIR Mhealth Uhealth. 2015 Jan 13; **3**(1): e3. doi: 10.2196/mhealth.4001.
15. Kellogg KM, Puthumana JS, Fong A, Adams KT, Ratwani RM. Understanding the Types and Effects of Clinical Interruptions and Distractions Recorded in a Multihospital Patient Safety Reporting System. J Patient Saf. 2021 Dec 1; **17**(8): e1394-e400. doi: 10.1097/PTS.0000000000000513.
16. Flynn GAH, Polivka B, Behr JH. Smartphone Use by Nurses in Acute Care Settings. Comput Inform Nurs. 2018 Mar; **36**(3): 120-6. doi: 10.1097/CIN.0000000000000400.
17. Giannetta N, Cianciulli A, Dionisi S, Figura M, Di Simone E, Di Muzio M. Orphan drugs: An European production, research and development policies. G It Farm Clin. 2019; **33**(1): 29-34. doi: 10.1721/3124.31053.
18. Dionisi S, Di Simone E, Franzoso V, Caldarola E, Cappadona R, Di Muzio F, et al. The application of the Theory of Planned Behaviour to prevent medication errors: a scoping review. Acta Biomed. 2020 Jun 20; **91**(6-S): 28-37. doi: 10.23750/abm.v91i6-S.9290.
19. Di Simone E, Di Muzio M, Dionisi S, Giannetta M, Di Muzio F, De Gennaro L, et al. Infodemiological patterns in searching medication errors: relationship with risk management and shift work. Eur Rev Med Pharmacol Sci. 2019 Jun; **23**(12): 5522-9. doi: 10.26355/eurrev_201906_18224.
20. Giannetta N, Marson D, Donna ED, Gaiotto B, Castellarin C, Di Simone E, et al. [Instruments to facilitate the decision-making process on how to administer infusions simultaneously in intensive care units: An Italian experience]. Italian. G It Farm Clin. 2020 Apr-Jun; **34**(2): 62-74. doi: 10.1721/3388.33657.
21. Giannetta N, Dionisi S, Ricciardi F, Di Muzio F, Penna G, Diella G, et al. [Look-alike, sound-alike drugs: Strategies for preventing medication errors]. Italian. G It Farm Clin. 2019 Jul-Sep; **33**(3): 119-28. https://dx.doi.org/10.1721/3214.31922.
22. Márquez-Hernández VV, Fuentes-Colmenero AL, Cañadas-Núñez F, Di Muzio M, Giannetta N, Gutiérrez-Puertas L. Factors related to medication errors in the preparation and administration of intravenous medication in the hospital environment. PLoS One. 2019 Jul 24; **14**(7): e0220001. doi: 10.1371/journal.pone.0220001.
23. Giannetta N, Dionisi S, Cassar M, Trapani J, Renzi E, Di Simone E, et al. Measuring knowledge, attitudes and behavior of nurses in medication management: cross-cultural comparisons in Italy and Malta. Eur Rev Med Pharmacol Sci. 2020 May; **24**(9): 5167-75. doi: 10.26355/eurrev_202005_21212.
24. McBride DL, Levasseur SA, Li D. Development and validation of a web-based survey on the use of personal communication devices by hospital registered nurses: pilot study. JMIR Res Protoc. 2013 Nov 26; **2**(2): e50. doi: 10.2196/resprot.2774.
25. McBride DL. Registered nurses' use of personal communication devices in hospitals (Doctoral dissertation, University of Hawai'i at Manoa). 2014. Available on: https://scholarspace.manoa.hawaii.edu/server/api/core/bitstreams/e63b8b47-6cd2-4acf-bff2-16ad6d538032/content [Last accessed: 2024 Mar 11].
26. McBride DL, LeVasseur SA. Personal Communication Device Use by Nurses Providing In-Patient Care: Survey of Prevalence, Patterns, and Distraction Potential. JMIR Hum Factors. 2017 Apr 13; **4**(2): e10. doi: 10.2196/humanfac-

tors.5110.
27. Leroy S, Glomb TM. Tasks interrupted: How anticipating time pressure on resumption of an interrupted task causes attention residue and low performance on interrupting tasks and how a "ready-to-resume" plan mitigates the effects. Organization Sci. 2018 May-Jun; **29**(3): 380-97. https://doi.org/10.1287/orsc.2017.1184.
28. Sanderson P, McCurdie T, Grundgeiger T. Interruptions in Health Care: Assessing Their Connection With Error and Patient Harm. Hum Factors. 2019 Nov; **61**(7): 1025-36. doi: 10.1177/0018720819869115. Epub 2019 Aug 30.
29. Bonafide CP, Miller JM, Localio AR, Khan A, Dziorny AC, Mai M, et al. Association Between Mobile Telephone Interruptions and Medication Administration Errors in a Pediatric Intensive Care Unit. JAMA Pediatr. 2020 Feb 1; **174**(2): 162-9. doi: 10.1001/jamapediatrics.2019.5001.
30. Liu J, Yu X, Kong L, Zhou X. Prevalence and factors associated with smartphone addiction among nursing postgraduates during the COVID-19 pandemic: a multilevel study from China's mainland. BMC Psychiatry. 2023 Dec 6; **23**(1): 915. doi: 10.1186/s12888-023-05369-5.
31. Auton A, Zaman S, Padayachee Y, Samways JW, Quaife NM, Sweeney M, et al. Smartphone-Based Remote Monitoring for Chronic Heart Failure: Mixed Methods Analysis of User Experience From Patient and Nurse Perspectives. JMIR Nurs. 2023 Jun 6; 6: e44630. doi: 10.2196/44630.
32. King D, Zaman S, Zaman SS, Kahlon GK, Naik A, Jessel AS, et al. Identifying Quality Indicators Used by Patients to Choose Secondary Health Care Providers: A Mixed Methods Approach. JMIR Mhealth Uhealth. 2015 Jun 5; **3**(2): e65. doi: 10.2196/mhealth.3808.
33. Venkatesh V, Morris MG, Davis GB, Davis FD. User acceptance of information technology: Toward a unified view. MIS Quarterly. 2003 Sep; **27** (3): 425-78. https://doi.org/10.2307/30036540.
34. Vandenbroucke JP, von Elm E, Altman DG, Gøtzsche PC, Mulrow CD, Pocock SJ, et al; STROBE Initiative. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. Epidemiology. 2007 Nov; **18**(6): 805-35. doi: 10.1097/EDE.0b013e3181577511.
35. Di Muzio M, Napoli C, Fiorinelli M, Orsi GB. Nurses distracted by smartphone use during clinical practice: Italian validation of the "Nurses' use of Personal Communication Devices (PCD) questionnaire". Appl Nurs Res. 2019 Oct; **49**: 23-8. doi: 10.1016/j.apnr.2019.07.008. Epub 2019 Jul 29.
36. Feroz A, Jabeen R, Saleem S. Using mobile phones to improve community health workers performance in low-and-middle-income countries. BMC Public Health. 2020 Jan 13; **20**(1): 49. doi: 10.1186/s12889-020-8173-3.
37. Esposito M, Rocq PL, Novy E, Remen T, Losser MR, Guerci P; ICURTASK study. Smartphone to-do list application to improve workflow in an intensive care unit: A superiority quasi-experimental study. Int J Med Inform. 2020 Apr; **136**: 104085. doi: 10.1016/j.ijmedinf.2020.104085. Epub 2020 Jan 21.
38. Bhardwaj N, Khatri M, Bhardwaj SK, Sonne C, Deep A, Kim KH. A review on mobile phones as bacterial reservoirs in healthcare environments and potential device decontamination approaches. Environ Res. 2020 Jul; **186**: 109569. doi: 10.1016/j.envres.2020.109569. Epub 2020 Apr 21.
39. Olsen M, Campos M, Lohning A, Jones P, Legget J, Bannach-Brown A, et al. Mobile phones represent a pathway for microbial transmission: A scoping review. Travel Med Infect Dis. 2020 May-Jun; **35**: 101704. doi: 10.1016/j.tmaid.2020.101704. Epub 2020 Apr 28.
40. Hwang IW, Choe JP, Park JH, Lee JM. Association between Physical Activity, Sedentary Behavior, Satisfaction with Sleep Fatigue Recovery and Smartphone Dependency among Korean Adolescents: An Age- and Gender-Matched Study. Int J Environ Res Public Health. 2022 Nov 30; **19**(23): 16034. doi: 10.3390/ijerph192316034.
41. Tu W, Nie Y, Liu Q. Does the Effect of Stress on Smartphone Addiction Vary Depending on the Gender and Type of Addiction? Behav Sci (Basel). 2023 Sep 30; **13**(10): 810. doi: 10.3390/bs13100810.
42. Bae EJ, Kim DE, Sagong H, Yoon JY. Problematic smartphone use and functional somatic symptoms among adolescents: Mediating roles of depressive symptoms and peer relationships by gender. Arch Psychiatr Nurs. 2022 Oct; **40**: 25-31. doi: 10.1016/j.apnu.2022.04.003.
43. Pucciarelli G, Simeone S, Virgolesi M, Madonna G, Proietti MG, Rocco G, et al. Nursing-Related Smartphone Activities in the Italian Nursing Population: A Descriptive Study. Comput Inform Nurs. 2019 Jan; **37**(1): 29-38. doi: 10.1097/CIN.0000000000000474.
44. Aguilera-Manrique G, Márquez-Hernández VV, Alcaraz-Córdoba T, Granados-Gámez G, Gutiérrez-Puertas V, Gutiérrez-Puertas L. The relationship between nomophobia and the distraction associated with smartphone use among nursing students in their clinical practicum. PLoS One. 2018 Aug 27; **13**(8): e0202953. doi: 10.1371/journal.pone.0202953.
45. Zarandona J, Cariñanos-Ayala S, Cristóbal-Domínguez E, Martín-Bezos J, Yoldi-Mitxelena A, Hoyos Cillero I. With a smartphone in one's pocket: A descriptive cross-sectional study on smartphone use, distraction and restriction policies in nursing students. Nurse Educ Today. 2019 Nov; **82**: 67-73. doi: 10.1016/j.nedt.2019.

Supplemental Materials

Tab S1. STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2-3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4-6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-6
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4-6
Bias	9	Describe any efforts to address potential sources of bias	4-5-6
Study size	10	Explain how the study size was arrived at	4-5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4-5-6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	n.a.
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6-11
		(b) Give reasons for non-participation at each stage	6-11
		(c) Consider use of a flow diagram	n.a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-11
		(b) Indicate number of participants with missing data for each variable of interest	6-11
Outcome data	15*	Report numbers of outcome events or summary measures	6-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-11
		(*b*) Report category boundaries when continuous variables were categorized	n.a.
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n.a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n.a
Discussion			
Key results	18	Summarise key results with reference to study objectives	11-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11-13

Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	11-13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Title page

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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