Transport and Chronic Injuries of Cell Phone use on Human Health: A Systematic Analysis of Epidemiological Evidence

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Research

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Abstract

Background Cell phone use brought convenience to people, but using phones for a long period of time or in the wrong way and with a wrong posture might cause damage to the human body. This study was designed to assess the impact of cell phone use on transport and chronic injuries.

Methods Studies were systematically searched in four database and relevant reviews were searched to identify additional studies. A total of 41 studies met the inclusion criteria.

Results Cell phone users were at a higher risk for transport injuries (RR: 1.37, 95%CI: 1.22–1.55), long-term use of cell phones increased the transport injury risk to non-use or short-term use (RR: 2.10, 95% CI: 1.63–2.70). Neoplasm risk caused by cell phone use was 1.07 times that of non-use (95% CI: 1.01–1.14); Compared with non-use, cell phone use had a higher risk of eye disease, with a risk of 2.03 (95% CI: 1.27–3.23), the risk of mental disease was 1.26 (95% CI: 1.17–1.35), the risk of neurological disorder was 1.16 (95% CI: 1.02–1.32), and a pooled risk of other chronic injuries, was 1.20 (95% CI: 0.98–1.59). Subgroup analyses found that motor crashes had significantly increased (OR: 1.25; 95%CI: 1.18–1.32), as well as the risk for hearing problems (OR: 4.54; 95%CI: 3.29–5.80), headaches (OR: 1.25; 95%CI: 1.18–1.32), and abnormal biochemical indicators (OR: 0.51; 95%CI: 0.04–0.99).

Conclusions Cell phone use at inappropriate situations has a negative impact on the human body. Therefore, it is necessary to use cell phones correctly and reasonably.

Background

Cell phones are wireless analog or digital communication devices that include mobile phones and smartphones. According to Ericsson's data, released in the first quarter of 2019, the number of cell phone users has reached 7.9 billion, with an increase of about 2% year-on-year[1]. China had the most net additions during this quarter (+ 30 million), followed by Nigeria (+ 5 million), and the Philippines (+ 4 million)[2]. In addition, the worldwide cell phone market has been predicted to reach a total of 1.5 billion shipment units by the end of 2019, and the pending arrival of 5G could attract more phone users by 2020 or 2021[2]. Although the popularity of cell phones facilitates people's daily lives and provides an effective auxiliary means for the treatment and management of diseases[3], the health hazards potentially caused by using cell phones are also a growing concern.

Numerous studies have shown that different habits of cell phone use could cause distraction, which displays various impacts on accident risks[4]. For example, nearly a quarter of all traffic accidents in the UK in 2013 were caused by drivers using phones while driving. Also, cell phone radiation has been classified as a possible carcinogen to humans[5]; the relationship between cell phone use and tumor incidence is disturbing, and radiation might cause tumors or accelerate the growth of sub-clinical tumors[6,7]. Besides, long-term and improper use of cell phones can cause permanent damage to vision[8], the cochlea, and the auditory cortex[9]. People need to maintain a deep neck flexion when using touch-screen mobile devices, otherwise it might cause neck pain[10]. Moreover, the excessive use of cell phones can negatively affect mental health from the perspectives of social fatigue[11], social addiction[12], and game addiction[13]. However, there are also some studies that believe that the available evidence does not yet suggest that cell phone radiation can cause damage to the human body, especially in the case of cancer. The injuries to the human body caused by cell phone use is controversial.

Transport injuries were usually caused by short-term use, and included transport injuries and unintentional injuries caused while using cell phones; these injuries included road injuries, electrical burns, and falling. Chronic injuries were usually recurrent, and often caused by local overloading and multiple injuries to tissues over time, such as hear loss, visual impairment, cervical injury, and internet addiction. Currently, people pay attention to injuries caused by cell phone use. Although most of the studies focused on a specific type of injury, such as tumors, headaches, and mental health[13–18], there are types of injuries that have not been reviewed yet and of which more evidence needs to be summarized. Given that the use of cell phones was growing rapidly, our study will provide a thorough review of the impact of cell phone use on the human body health, including transport injuries and chronic injuries.

Methods

1.1 Search strategy

Two of the authors (XC and CX) systematically searched the databases PubMed, EMBASE, Cochrane, and Web of Science up to April 4, 2019. The search was limited to human body studies published in the English language. In addition, additional literature was screened by manually searching for the reference lists of recent reviews and included studies. The two authors (XC and CX) worked simultaneously, but independently screened the studies with the inclusion criteria and the extracted data, and assessed the study's quality. The results were cross-checked by each other, and any disagreement on study selection, data extraction, and study quality assessment was resolved by a third author (YH).

1.2 Inclusion And Exclusion Criteria

Transport injuries were mainly road injuries (car accidents, motorcycle accidents, or motor crashes). Chronic injuries included neoplasm disease(brain tumor, thyroid cancer, glioma and astrocytoma), mental disease (Attention Deficit Hyperactivity Disorder [ADHD], Nomophobia-anxiety, insecurity, anger, discomfort), neurological disorder (headaches, sleep problems), sensory system disease (eye disease, hearing problem), oral health, wrist extension damage, reproductive health, and other chronic injuries (including DNA damage, genotoxic effects, blood-cerebrospinal fluid barrier [BCSFB], serum S100B levels, tPSA, fPSA, fPSA/tPSA, DNA intergrity, chromosomal damage). Our study inclusion criteria were (i) focused on damage, including transport and chronic injuries, instead of promoting healthy outcomes; (ii) using cell phones, including digital phone and cell phone radio frequency radiation); (iii) transport injuries occurring during cell phone use; chronic injuries resulting from cell phone use rather than any other cause (e.g., occupational injuries); (□) published in English; and (□) outcome indicators including Odd Ratios/ Relative

Risks (OR/RR) and their 95% confidence intervals (CIs) or the mean with their standard deviation (Mean ± Standard Deviation, M ± SD).

Abstracts, comments, conferences, replies, responses, reviews (including systematic reviews), case reports, and animal studies were excluded from the present analysis. Additionally, studies with incomplete data or duplicate publications were also excluded.

1.3 Data Extraction And Quality Assessment

Two reviewers (XC and CX) independently conducted data extraction and assessed the study's quality according to the predefined inclusion criteria. The following information was collected using standardized data extraction forms: author information, publication year, study design, participant age, sample size, study area, measures of cell phone use, measures of outcome-related behavior, and key outcomes. All data were double-checked.

The Newcastle−Ottawa Scale (NOS) was designed for the evaluation of case-control studies and cohort studies. The evaluation criteria for cross-sectional studies included 11 items recommended by the Agency for Healthcare Research and Quality (AHRQ). The quality of each study was graded as good, fair, or poor. To be rated as good, studies needed to meet all criteria. A study was rated as poor when one (or more) domain was assessed as having a serious flaw. Studies that met some but not all criteria were rated as fair. Any disagreements or discrepancies regarding study selection, data extraction, and quality assessment were resolved by consensus.

1.4 Data Analysis

A random-effects model was used to estimate the overall pooled estimates. Tests for heterogeneity between the study results were performed with the Cochran's Q statistic and quantified with the I^2 statistic.

To examine the robustness of the findings, we performed subgroup analyses by study country, participant age, sample size, and study-specific outcomes (transport and chronic injury). To validate the robustness of the findings, we performed a sensitivity analysis. The potential for publication bias was graphically explored through the production of funnel plots and tested for significance with Egger's test and Begg's test. All statistical procedures used a two-sided significance level of 0.05 and were conducted with Stata version 13.0.

Results

A detailed flowchart of the literature searching process and study identification is presented in Fig. 1. First, 4,225 studies were identified by the initial database search, and three articles were obtained by searching references; 2,324 articles were still included after the removal of duplicates. After screening the titles and abstracts, 1,922 records were excluded because they did not meet the selection criteria [e.g., case reports (n

= 9), summary reviews (n = 117), animal studies (n = 255), not about cell phone use (n = 1257), non-English (n = 2), replies/abstracts (n = 23), and no outcome indicators (n = 259)]. Then the full text articles were assessed for eligibility; 142 records were excluded because they were duplicates (n = 2), a case report (n = 1), summary reviews (n = 9), non-crowed research (n = 29), not about cell phone use (n = 10), not in English (n = 3), a reply (n = 1), or lacked outcome indicators (n = 87). Finally, 41 studies[12–53] were included, including cohort studies (n = 10), case–control studies (n = 20), and cross-sectional studies (n = 11). The details of the search strategy are presented in the Appendix (Table S1).

The characteristics of the included articles are presented in Table S2. Twenty-eight studies were published between 2011 and 2019, 12 were published between 2001 and 2010, and 1 was published in 1997. The sample sizes of the included studies ranged from 6 to 15, there were 406,515 participants in total, and all participants were over 7 years old. Of the included studies, 8 studies were carried out in the United States, 5 in Sweden, 3 in Canada, 3 in Korea, 2 in China, 2 in Vietnam, 2 in Iran, 1 in Denmark, 1 in Italy, 1 in Malaysia, and 1 in Brazil. The remaining studies lacked relevant regional information. Outcomes were divided into transport and chronic injuries. Fifteen studies focused on transport injuries, which were mainly related to road injuries and unintentional injuries, such as electrical injuries and explosions. Twenty-six studies focused on chronic injuries, such as tumors, ocular health, oral diseases, DNA damage, joint injuries, hearing damage, and male reproductive health conditions.

The results of the quality assessment indicated that 16 studies were of good quality, and 25 were rated as fair (Table S3).

Compared with non-cell phone users, people who use cell phones had a significantly higher risk of all of injuries, with a pooled OR/RR of 1.55 (n = 15,517,418; 95% CI = 1.40–1.71; I2 = 93.7%). The risk was 1.37 for using cell phones (n = 15,451,501 ; 95% CI = 1.22–1.55; I2 = 96.6%) compared with non0cell phone users; and the top three relative risks were 4.78 (95% CI = 3.46–6.60) and 3.90 (95% CI = 2.70–6.10) for motor crashes, 2.38 (95% CI = 1.30–4.30) for car accidents. Those who use cell phones for long-time had a 2.10-fold (95% CI = 1.63–2.70) higher risk of transport injury than those who did not or had used them for short-time; the top three relative risks were 8.32 (95% CI = 2.83–24.42), 7.05 (95% CI = 2.64–18.83), and 6.76 (95% CI = 2.60–17.55), and the corresponding outcomes were car accidents and motor crashes (Fig. 2).

[The neoplasm included brain tumor, glioma cancer, thyroid cancer, and astrocytoma.]

A continuous data analysis showed that the hearing risk of the trial group was 4.54 times higher than that of the non-cell phone user group, whereas there was no significant difference between the two groups (WMD = 4.54, 95% CI = 3.29–5.80, I^2 = 20.6%). Compared to non-cell phone users and short-term users, the risk for Nomophobia among long-term users was − 0.06 (WMD = -0.06, 95% CI = -0.74–0.63; I^2 = 0.0%; Fig. 5B). The risk for the other chronic injuries among long-term users was 1.35 (WMD = 1.35, 95% CI = 0.86–1.85; I^2 = 98.2%) and the outcomes included DNA integrity, tPSA, fPSA, fPSA/tPSA, Chromosomal damage, DNA breaks, and genotoxic effects (Fig. 5C) Fig. 5D showed that using cell phones increased the risk of oral health (WMD = 218.48; 95% CI = 2.93– 434.02; I^2 = 0.0%) and wrist extension (WMD = 0.82; 95% CI = -0.53– 2.16; I^2 = 91.4%).

[The non-neoplasm injuries included eye disease, mental health (ADHD), neurological disorder [headaches, sleep problems], and other chronic injuries (including BCSFB, Serum S100B levels).]

[Chronic injuries included hearing problem, mental health [ADHD, Nomophobia-anxiety, insecurity, anger, discomfort], oral health, and other chronic injuries [including tPSA, fPSA, fPSA/tPSA, DNA integrity, chromosomal damage, DNA breaks, genotoxic effects]

Subgroup analyses showed a consistent increase in the overall risk of cancer in the dialysis population (Table 1). Participants from the US (OR = 1.35; 95% CI = 1.18–1.55), Denmark (OR = 1.25; 95% CI = 1.18–1.32), and participants aging from 18 to 35 (OR = 1.62; 95%CI = 1.31–2.00) had a higher risk for human body injuries during cell phone use. Similarly, the population with a larger sample size showed a higher risk for injuries compared to the population with a smaller sample size. The risk for motor crashes significantly increased as a result of transport injuries (OR = 1.43; 95% CI = 1.25–1.64); hearing problems (OR = 4.54; 95% CI = 3.29–5.80), headaches (OR = 1.25; 95% CI = 1.18–1.32), and abnormal biochemical indicators (OR = 0.51; 95% CI = 0.04–0.99) were the highest risks of chronic injuries to human body.

Among the participants with a various duration of cell phone usage, Canadians and Koreans had a higher risk for injuries to the human body compared to the other populations, although there was no statistical difference. In studies with a participant sample size ranging from 100–500 and with participants aging from 18 to 35 years, there was a higher risk for injuries. In general, cell phone use would increase the risk for injuries to the human body. Similarly, motor crashes were the highest cause of human body injuries as a result of transport injuries (OR = 3.23; 95% CI = 1.65–6.30), DNA damage (OR = 7.52; 95% CI = 2.23–12.81), male reproductive health conditions (OR=-4.69; 95% CI = -5.64 to -3.75), and mental health conditions (OR = 1.20; 95% CI = 1.05–1.37) were associated with a significantly higher risk for chronic injuries to the human body.

Publication biases may exist when the publication status depends on the statistical significance of the study results. We conducted a funnel plot analysis to check for a potential publication bias; the funnel plot was generally symmetric, indicating the absence of a publication bias (Figure S1).

Table 1
Subgroup analyses of the risk of injuries with cell phone use.

Component		Number of Studies (Included entries)	OR (95%CI) random effects/WMD*
Use or not			
Country	Iran	2 (2)	1.08 (0.51, 2.27)
	Canada	3 (3)	1.95 (0.94, 4.07)
	US	5 (13)	1.35 (1.18, 1.55)
	Denmark	1 (6)	1.25 (1.18, 1.32)
	Sweden	4 (7)	1.06 (0.91, 1.24)
Sample size	100–500	5 (8)	1.17 (0.79, 1.72)
	500–1000	5 (6)	1.76 (1.14, 2.71)
	> 1000	10 (22)	1.21 (1.11, 1.32)
Age	1–18	4 (9)	1.23 (1.15, 1.32)
	18–35	4 (4)	1.62 (1.31, 2.00)
	35–65	5 (7)	1.02 (0.87, 1.21)
Transport injury	Car accident	3 (5)	1.31 (0.81, 2.13)
	Motor crash	6 (11)	1.43 (1.25, 1.64)
	Motorcycle accident	3 (3)	1.13 (0.51, 2.48)
Chronic injury	Mental health	2 (2)	1.37 (0.54, 3.51)
	Headaches	1 (6)	1.25 (1.18, 1.32)
	Tumor	4 (7)	1.07 (0.93, 1.23)
	Abnormal biochemical indicators	2 (2)	1.04 (0.60, 1.82)
Chronic injury*	Abnormal biochemical indicators	2 (4)	0.51 (0.04, 0.99)*
	Hearing problem	1 (4)	4.54 (3.29, 5.80)*
	DNA damage	1 (1)	0.13 (-0.15, 0.40)*
Use of duration			
Country	US	3 (23)	1.20 (0.78, 1.84)

Component		Number of Studies (Included entries)	OR (95%CI) random effects/WMD*
	Canada	1 (14)	1.91 (1.54, 2.35)
	Korea	1 (12)	1.20 (1.05, 1.37)
	Sweden	4 (37)	1.06 (0.98, 1.15)
Sample size	100–500	4 (19)	1.89 (1.32, 2.71)
	500–1000	1 (12)	1.13 (0.99, 1.28)
	> 1000	5 (55)	1.16 (1.07, 1.25)
Age	1–18	1 (12)	1.20 (1.05, 1.37)
	35–65	6 (41)	1.16 (1.03, 1.30)
Transport injury	Car accident	2 (21)	1.95 (1.49, 2.55)
	Motor crash	1 (4)	3.23 (1.65, 6.30)
Chronic injury	Mental health	1 (12)	1.20 (1.05, 1.37)
	Tumor	4 (41)	1.07 (1.00, 1.15)
	Abnormal biochemical indicators	2 (8)	1.26 (0.91, 1.74)
Chronic injury*	Nomophobia	1 (4)	-0.06 (-0.74, 0.63)*
	Oral problem	2 (9)	0.01 (-0.15, 0.18)*
	DNA damage	2 (4)	7.52 (2.23, 12.81)*
	Male reproductive health	1 (4)	-4.69 (-5.64, -3.75)*
	Joint injury	1 (2)	0.82 (-0.53, 2.16)*

[* Outcome measures are continuous variables.]

Discussion

Our study included large participant-level cohort, cross-sectional and case–control studies on the impact of cell phone use on human body outcomes. The findings suggested that cell phone use increased the risk of transport and chronic injuries involving the human body. The risk of transport injuries due to cell phone use was 1.55 times higher than when not using cell phones, and car accidents and motor crashes were the highest relative risks of traffic injuries;Cell phone use also increased the risk of chronic injuries.

Consistent with the findings of previous studies[55–58], cell phone use was more prone to transport injuries. Phone use while driving has become one of the priority issues in road safety, given that it may lead to decreased situation awareness and deteriorated driving performance. Although it is difficult to assess the absolute increased risk for collision due to distraction of the driver caused by using cell phones, existing studies have shown that the risk of talking on the phone while driving is significantly higher than that of undistracted driving and is comparable to the risk of drunk driving[55]. Texting or typing is more likely to increase the risk of traffic than other types of observable distraction, and previous risk studies have shown that such visual manual tasks greatly increase the risk of a crash[59, 60]. Ludovic[61] et al. found that cell phone use while driving was a significant distraction, especially in young drivers, thus becoming a leading cause of motor vehicle crashes. For example, drivers were more likely to miss traffic signals and were involved twice as often in car crashes when having a phone conversation while driving. A study conducted by the Florida State University found that even when a user is not using a cell phone, the vibration or beeping of the phone will attract the user's attention, which may severely impact the driving. Alghnam[62] investigated the association between cell phone use and distracted driving through a case–control method and found that using cell phones while driving would increase the risk of road traffic injuries.

Some interventional driving strategies and preventive measures have reduced the risk of traffic accidents among people, such as the graduated driver licensing program and advertising campaigns. So far, few therapeutic approaches have been implemented. For example, United States, Great Britain, Canada, South Africa, and Australia had developed and used “The Graduated Driver Licensing” (GDL) program, which allowed drivers to gain experience in low-risk driving conditions by adding an “intermediate” phase between the learning stage and the acquistion of the driving license[63]. While many studies showed that the effectiveness of educational and preventive road safety programs is yet to be confirmed[64].

In addition, previous studies found that excessive use of cell phones can cause chronic injuries. Cell phone radiation has been classified as possibly carcinogenic to humans. Previous evidence of damage from RF-EMF is the strongest for cancer caused by long-term exposure to cell phones, and especially brain tumor gliomas[65], glioblastomas[66], and acoustic neuromas. In fact, the rates of brain tumors are increasing in Sweden, and the use of wireless phones has been suggested to be the cause[67]. There appears to be sufficient evidence that RF-EMF, although not causing tissue heating, can cause non-thermal biological effects. Deniz[68] evaluated the effects of phones on the human brain using stereological and spectroscopic methods and neurocognitive tests, and found that a lack of attention and concentration may occur in subjects who talk on the phone for a longer amount of time, unlike those who use phones relatively less. Some studies have shown that cell phone use can also cause wrist damage, such as cervical vertebra injuries and wrist joint injuries[69]. Fei[70] and Kim[71] found that cell phone use that was not conducive to the proper spinal posture increased the risk of chronic neck and shoulder pain, and pain and fatigue worsened with longer cell phone use. People are in a relaxed state while using their cell phones, especially the neck, which is in a bent state. It was shown that there was a positive correlation between neck flexion and neck force, as well as head and neck posture in the cervical spine stress and related neck pain[72]. Besides, long-term use of cell phones was harmful to the mental health, and caused headaches and sleep disorders[73,74].

They also found that using cell phones before bedtime could cause sleep disorders and could lead to a rapid decline in cognitive and learning abilities among students. Cell phones are playing an increasingly important role in our lives; people have become dependent on cell phones and suffer from "no mobile phone phobia" (i.e., when not having a cell phone, individuals feel discomfort, insecurity, anxiety, or anger)[44]. Finally, previous studies have shown that cell phone use can cause DNA damage[75,76]. Oxidative stress is known to play a central role in the development of cancer and aging, and serves as a signaling agent in the inflammatory response. The majority of recent studies reported that the RFR emitted from cell phones causes oxidative stress[77]. Oxidative stress related to RFR leads to lipid, protein, and DNA damage in various tissues[78]. Oxidative DNA damage may thus play an important role in mutagenesis, carcinogenesis, and aging[79–80].

The inclusion criteria for our study are rigorous, and thus, some reports were excluded. Most studies have concluded that cell phones are harmful to humans. In addition to the traffic accidents mentioned above, there are other reports of acute injuries caused by cell phones. For example, the incidences of taking selfies and sharing them on social media as well as selfie-related behaviors are increasing, particularly among young people, which possibly leads to selfie-related trauma[81,82]. Other studies have reported on physical damage caused by cell phones, such as ear trauma, thigh injuries, electrical burns[8], and injuries caused by phone explosions[83–85]. Furthermore, scientists have suggested that electromagnetic fields (EMFs) generated by such devices may have long-term harmful effects, including an increase in infertility, Alzheimer’s disease, and other neurodegenerative diseases[86]. Alzheimer's disease is increasing in many countries, and its association with ELF-EMF occupational exposure has been clearly demonstrated through several independent epidemiological studies. A prospective epidemiological study[87] has shown that Alzheimer’s disease is significantly associated with chronic ELF-EMF occupational exposure. In addition, at greater EMF strengths or shorter exposures, the ability of the body to develop compensation mechanisms is reduced, and the potential for heart-related effects increases. This suggests that the presently allowed radiation emission levels for cell phones, although low, might be sufficient to induce biological effects. However, determination of whether these effects might cause any significant health effects requires further investigation. Inskip et al[88–90] also reported that the existing data are not sufficient to support the assumption that tumors were caused by cell phone usage.

Our study also has some limitations. First, "damage" and "injury" were used as search queries in our study to retrieve reports on the health effects of cell phones. Other adverse outcomes caused by phones may have been missed, and we expect to include more outcomes in future studies. Second, the small sample sizes of several studies could limit the reliability of their statistical results in specific categories and increase the likelihood of chance differences. More empirical evidence is needed to have more reliable estimations of cell phone use and its impact on human health, especially concerning chronic injuries. Third, only 10 of the 41 included studies were longitudinal studies, we lacked more longitudinal studies to confirm the causal relationship between cell phone use, and human transport and chronic injuries. Fourthly, the different environments and behaviors of using mobile phones might lead to different injury risks, we did not consider different patterns or reasons for using mobile phones in different regions and by different people, nor did we further analyze the specific types and purposes of using mobile phones, such as texting or making phone calls. Finally, there was a significant heterogeneity in our study, and we did a subgroup analysis to explore the source of heterogeneity. However, the results of this subgroup analysis did not fully explain such heterogeneity, and we need to conduct further studies to explore this.

Conclusions

There is growing evidence that cell phone use impacts the human body. Our study suggests that the use of cell phones causes not only transport injuries, but also chronic injuries to the human body. Although some findings are still controversial, the harm that cell phones have caused to the human body cannot be underestimated, and more research is needed to explore the direct evidence of damage to the human body. Therefore, it is necessary for cell phone users to reduce the cell phone usage time, maintain a correct posture when using cell phones, and take appropriate protective measures, such as anti-blue light glasses. As for the manufacturers, they need to improve their technology to cause less radiation and light damage to the human body. Cell phone use is ubiquitous and facilitates people's daily lives. It is essential to increase the awareness of correct and reasonable use of cell phones to reduce the injuries caused by cell phone use.

List Of Abbreviations

Abbreviations	Full text
ADHD	attention deficit hyperactivity disorder
BCSFB	blood-cerebrospinal fluid barrier
OR	odd ratios
RR	relative risks
95%CI	95% confidence intervals
M ± SD	mean ± standard deviation
NOS	Newcastle–Ottawa Scale
AHRQ	Agency for Healthcare Research and Quality

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

All data generated and analysed during this study are included in this published article [and its supplementary information files, Table S2].

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit the study for publication.

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Figures

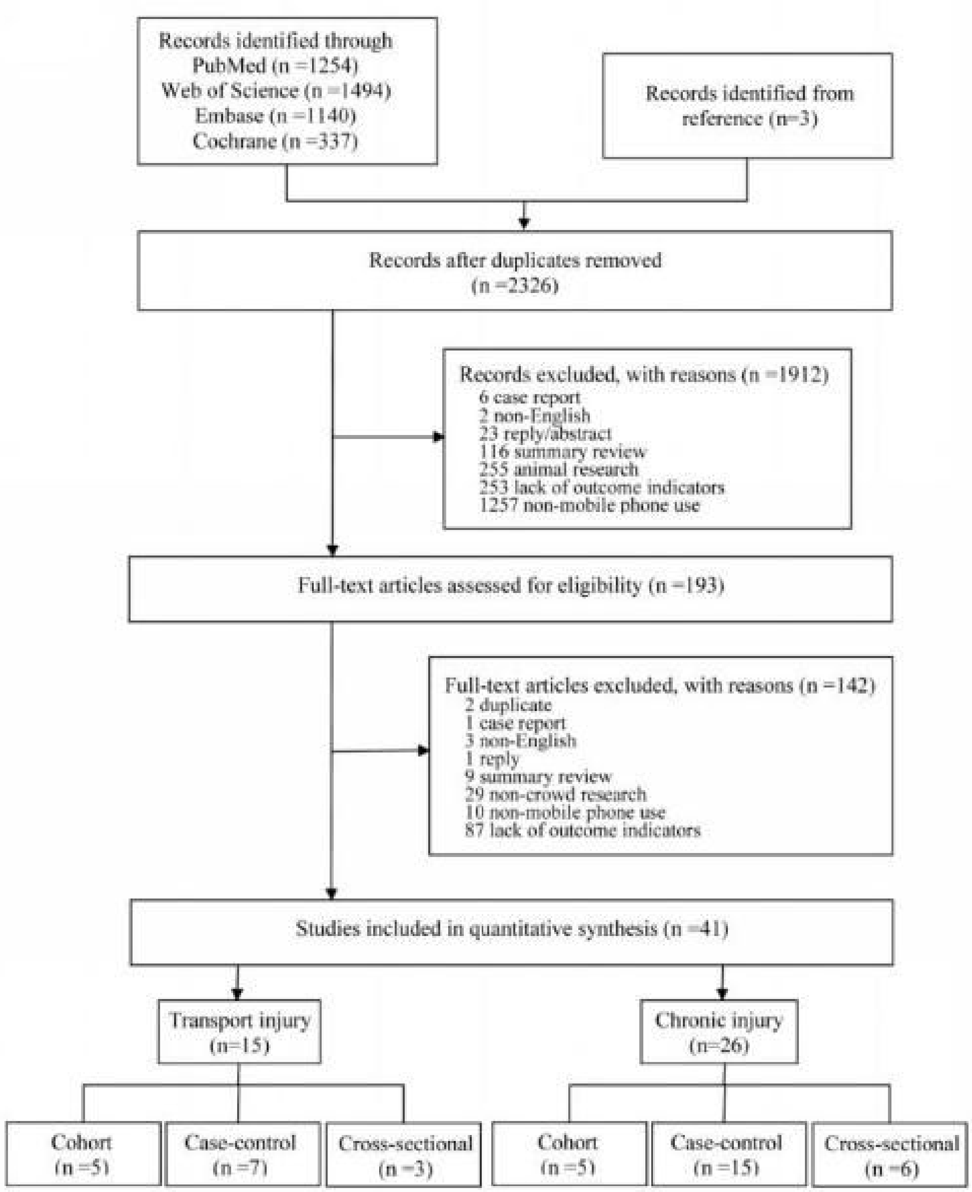

Figure 1

Flowchart of the selection of articles.

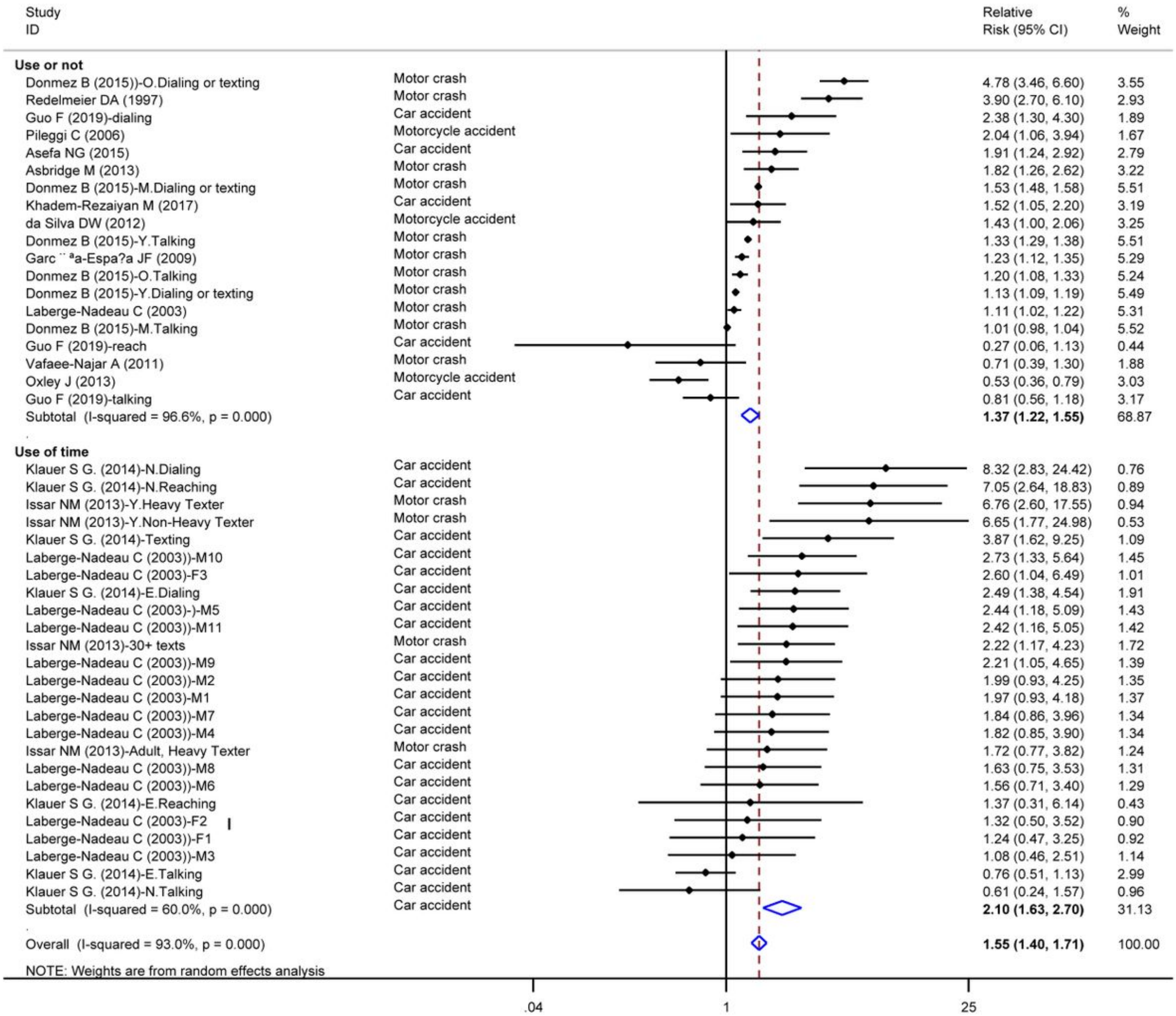

Figure 2

Forest of transport injury risk and cell phone use.

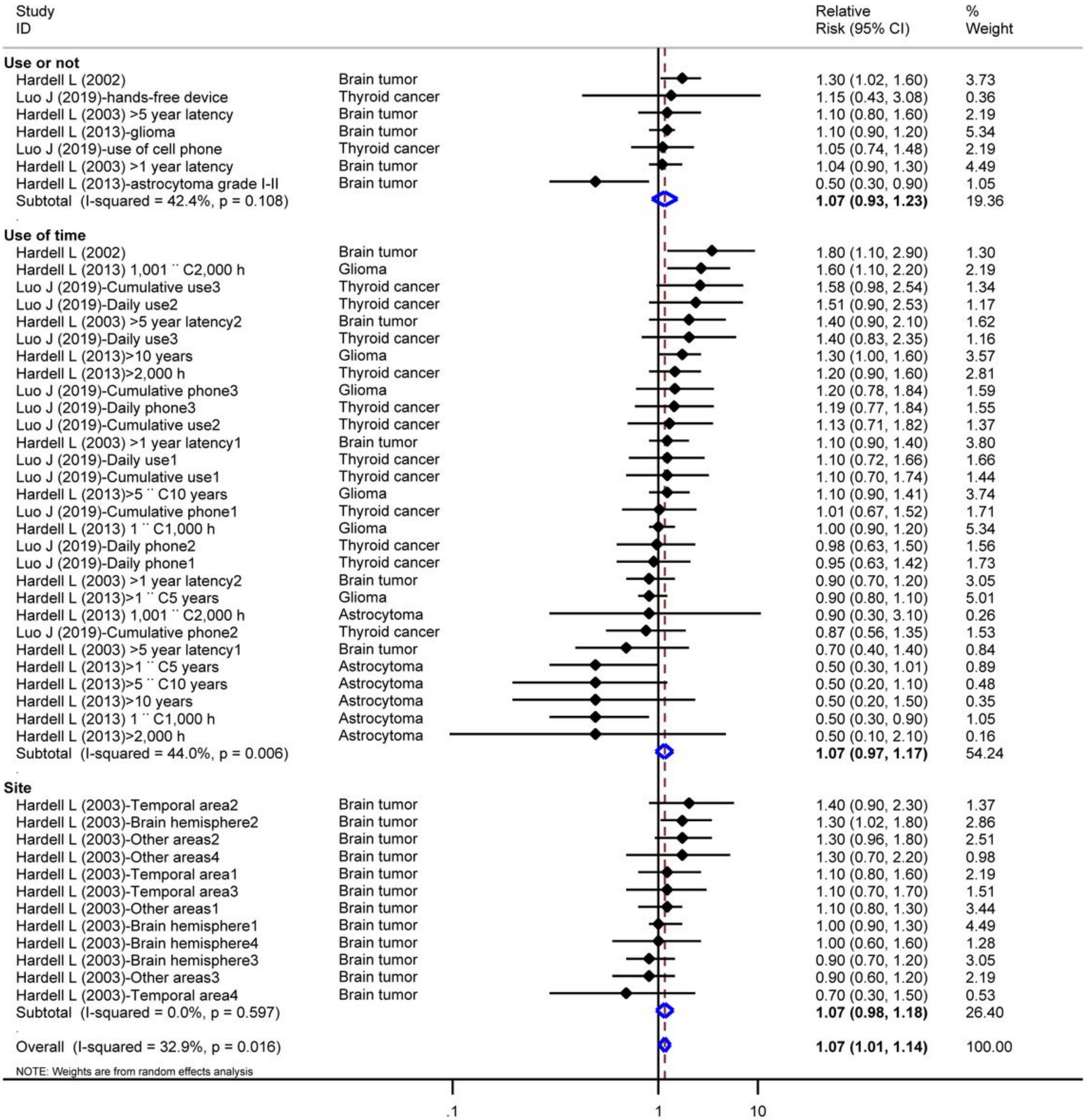

Figure 3

Forest of chronic injury risk (neoplasm injury) and cell phone use.

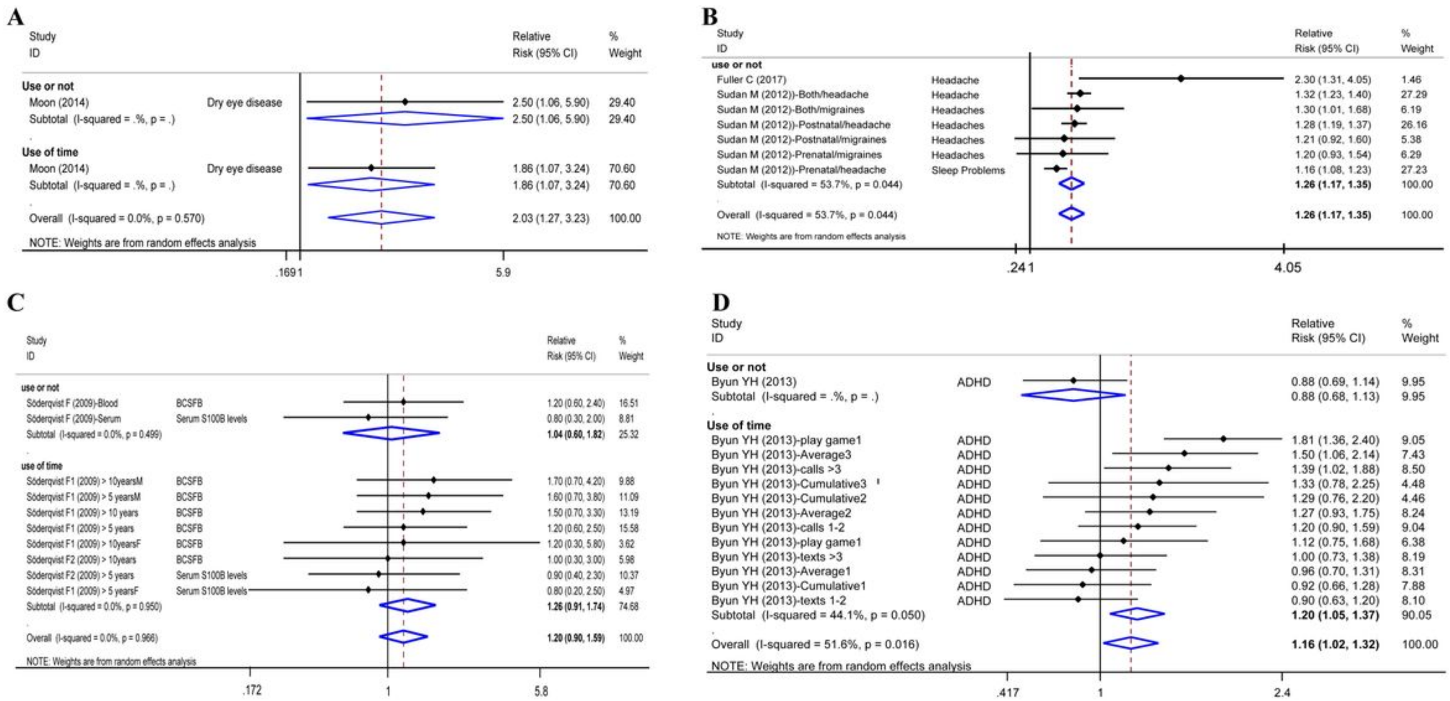

Figure 4

Forest of chronic injury risk (non-neoplasm injury) and cell phone use.

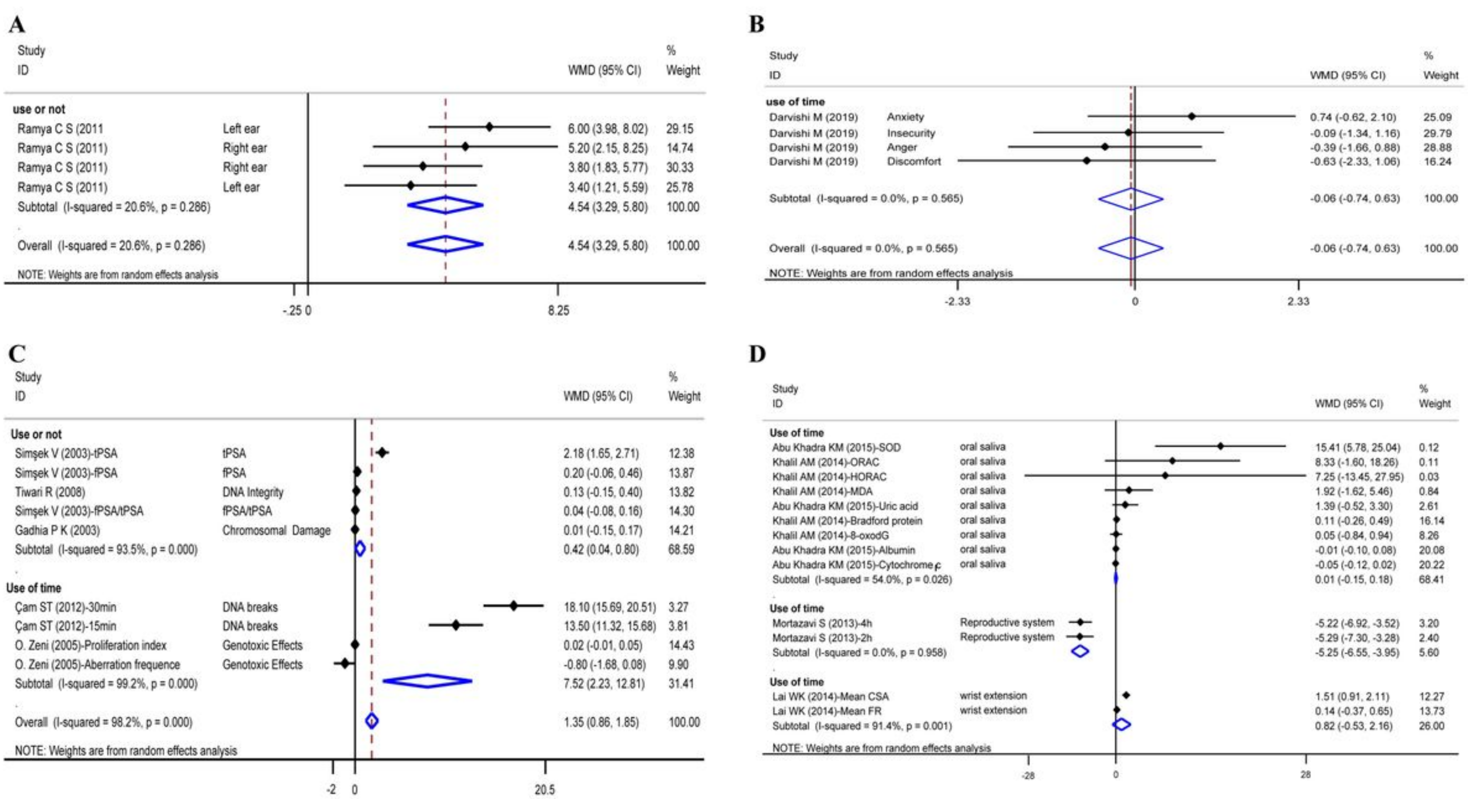

Figure 5

Forest of chronic injury risk and cell phone use (continuous data).

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