

Association of Secondhand Smoke (SHS) Exposure with Health-Related Quality of Life (HRQoL): A Systematic Review

Susi Ari Kristina*, Ni Putu Ayu Linda Permitasari

Department of Pharmaceutics, Faculty of Pharmacy, Universitas Gadjah Mada, Yogyakarta, INDONESIA.

ABSTRACT

Secondhand smoke (SHS) has been well established as one of risk factor for many diseases. Although exposure to SHS has been associated with various medical conditions, the evidence on the effect of it on health-related quality of life (HRQoL) is still limited. Therefore, the objective of this study is to examine the association between SHS with HRQoL. Terms and keywords relevant to secondhand smoking behaviors and HRQoL were used in a search of the electronic database. Three electronic databases (PubMed, Science Direct, Cochrane Database of Systematic Reviews) and Google Scholar were used. Searches were limited to English language, included papers: a) had clearly defined measures of SHS exposure and b) had clearly defined measures of outcome variables related to HRQoL. A total of 42 studies were initially retrieved and reviewed. After further review of references from the retrieved studies, 8 studies were finally selected that met all eligibility criteria. The reviewed studies consisted of three cross-sectional study analyses, two cohort studies, one longitudinal analysis and one study using bivariable and multivariable analysis. Those

findings consisted of varied number of population and conducted from different countries. Exposure to SHS was associated with generally lower HRQoL, suggesting that detrimental effects of SHS exposure on HRQoL are not limited to patients with diseases (chronic disease, COPD, or heart failure) but also in healthy never smoking children and adult, both in man and woman. Our review study showed that SHS exposure towards healthy or people with disease, children, adult, both in man and woman were associated with decreased HRQoL. It can provide new evidence for stronger smoke-free policies on public places and promoting smoke-free homes.

Key words: Secondhand smoke, SHS, Health-related quality of life, Quality of life, Chronic diseases.

Correspondence:

Dr. Susi Ari Kristina

Faculty of Pharmacy, Sekip Utara Yogyakarta 55281, INDONESIA.

Phone no: +62274543120

E-mail id: susiari_k@ugm.ac.id

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INTRODUCTION

In the world, more than 0.6 million premature deaths and 10.9 million disability adjusted life years (DALYs) occur due to non-smokers who becoming secondhand smokers.¹ According to global burden of disease (GBD) calculation, secondhand smoking contributed 9,316,121 DALYs globally in 2013.² Secondhand tobacco smoke exposure remains a global health problem with 40% of children and 34% of non-smoking adults exposed and resulting in 603,000 attributable deaths from ischemic heart and other cardiovascular diseases, respiratory disorders, asthma and lung cancer.³ SHS exposure also known as risk factor of various diseases such as coronary heart disease, stroke in adults and infant death syndrome in infants and children.¹

Many diseases related to SHS may cause by there are 4000 harmful chemical compounds contained in the heterogeneous aerosol generated by burning tobacco, including nicotine, tar, cyanide, benzene, cadmium, methanol, ammonia and arsenic.² The amount of those harmful substances in the body of secondhand smokers is greater than active smokers, because the toxins inhaled through the breath are not filtered; make them more susceptible to health problems compared to active smokers.²⁻³

Those conditions significantly can increase and related with low tobacco control measures and the high smoking prevalence especially in the developing countries. SHS exposure is still common in many places and varied in locations. Although the exposure to SHS is very high from public places, the duration of the exposure is not proportional to the time at home or workplace where people often spend most of their time.⁴ Furthermore, although the prevalence rate of smoking among women is relatively low, women and children still have health risks as secondhand smokers due to men smoking at home or elsewhere.⁵

As there is no any safe level of SHS exposure, health-related quality of life (HRQoL) is an important health outcome for evaluating the implementation of policies and predicting morbidity and mortality due to secondhand smoking behavior. HRQoL is a comprehensive measurement

of physical, social and mental functions⁶ and has been used to estimate the impact of chronic disease, identify health disparities in population and inform policies and patient management¹. Decreased HRQoL is known to be associated with increased risk of death, hospitalization and increased health care costs at the population level.⁷

The decreased HRQoL in current active smokers has been widely investigated, but only limited data are available on the effects of people who get SHS exposure on HRQoL. Given this background, the aim of this study was to evaluate the association between SHS with HRQoL in the general population worldwide using data obtained from systematic review. The review will be conduct to see the association between SHS and HRQoL in term of mental health, psychological distress and its correlation to the severity of some diseases.

MATERIALS AND METHODS

This research is a systematic review to find out the association of SHS with HRQoL of several related studies. There were 3 main steps to gain the data; first we identify and select related research about our topic. Second, we assess the retrieved research that met all eligibility criteria. Then third, we made the review and data extraction for each study.

Study identification

Three electronic databases (PubMed, Science Direct, Cochrane Database of Systematic Reviews) and Google Scholar were initially searched in March 2018. We performed a literature search for published articles in the English language that reported on the relationship between SHS exposures and used specific health quality of life measurements prior to recent years (2007-2017). Key terms used for the search were as follows: secondhand smoke OR secondhand smoking OR passive smoker OR environmental tobacco smoke AND health quality of life OR quality of life. Only studies that had clearly defined measures of SHS exposure and of the main outcome variables of interest were included.

Study Quality Assessment

A total of 42 studies were initially retrieved and reviewed. After further review of references from the retrieved studies (due to full-text cannot be accessed by Universitas Gadjah Mada database, English language of the full-text were not available, non-related quality of life instruments of the studies and duplicate topic of the articles), only 8 studies were finally selected that met all eligibility criteria. The PRISMA diagram of retrieved studies is shown in **Figure 1** below. Meta-analytic techniques could not be adequately performed because of the heterogeneity in the definitions of measures and designs across studies. However, to facilitate our analysis and discussion, we have grouped the results of the review to examine the associations between secondhand smokers and HRQoL in healthy persons and persons with diseases.

Data extraction

Data were independently extracted by two independent researchers. Data extraction form included details of study, research sample, countries, SHS measurements, quality of life instruments and the result of each study. Non-agreement on the extracted data was resolved by discussion among the authors.

RESULTS

Description of the study

The retrieved studies consisted of three cross-sectional study analyses, two cohort studies, one longitudinal analysis and one study using bivariable and multivariable analysis. Those findings consisted of varied number of population and all conducted from different countries (Switzerland, San Fransisco, South Korea, China, Korea, Thailand, USA and California). With regard to measurement of SHS exposure, six of the studies assessed SHS exposure gained in the home, public place and/or restaurants/bars; one study particularly from workplace for wagers; and one study particularly from home for household.

The primary predictor for exposure to SHS for all studies was asked by interview. Subjects were considered to have been exposed to SHS if they answered "yes" to the question like "have you been exposed to secondhand smoke by any chance?" Only one study measured secondhand smoking status through biological means (i.e., urinary cotinine level), with a high-sensitivity assay for urinary cotinine level as the parameter. Meanwhile, the frequency of SHS was quantified differently by each study. Most studies assessed SHS frequency through the number

of hours per day exposed, while others assessed for the total hours of secondhand smoke per week. All studies defined the subjects of the research were non-smokers.

Three studies examined the association between SHS and HRQoL using 36-Item Short Form Health Survey (SF-36) with 8 domains (physical functioning, role physical, bodily pain, general health, vitality, social functioning, emotional and mental health) as QoL instruments. One study used WHO-Five Well-Being Index. Other studies used SF – 8, SF – 12 and one study which see the association of SHS in COPD patients was using Airways Questionnaire 20-R to assess the severity and quality of life. Five studies were conducted to see the association between SHS and HRQoL in healthy people, meanwhile three studies were show the association in people with diseases which are heart failure, chronic disease and COPD.

Secondhand smoke and HRQoL

The summary of eight studies that discuss about the association between SHS with HRQoL used in this systematic review is in **Table 1**. The study of Bridevaux *et al.*⁶ show the high SHS exposure has a greater reduction in HRQoL. Exposed men had lower scores for the role physical domain and a trend toward lower scores in other domains. When comparing the unexposed group with the groups exposed <2h/day and >2h/day, exposure to a longer duration of SHS was significantly associated with lower scores on the EQ-5D index and the EQ-VAS.⁷

Meanwhile from the place of SHS exposure, those exposed to SHS in outdoor public places had lower scores on most SF-12 domains for physical and mental. SHS exposure in one's home and workplace was associated with lower scores on role physical, body pain and role emotional. SHS exposure in friends' homes was additionally associated with lower social functioning and mental health scores.¹ Besides that, in women, exposure to SHS at home was associated with a stronger negative effect on HRQoL than at work and in public spaces.⁶

The presence of an adult smoker and increasing number of smokers in the home are both negatively associated with MCS and PCS scores in bivariable analyses for maternal health.

Moreover, the previously unrecognized child health risk: living with smokers is independently associated with worse physical and mental health among nonsmoker mother at home.⁸ Poor -psychological well-being was also significantly higher for SHS exposure group compared to non-exposure group during work times for wagers in Korea.⁹

In people with disease study, self-reported SHS exposure is associated with greater chance of COPD exacerbation resulting in emergency health care utilization, including poorer physical health status, HRQoL and exercise capacity.¹⁰ The well-being amongst passive smokers of patients with chronic diseases was apparent even after nearly a decade of follow-up.¹¹ Other study also report that exposure to SHS in people with heart failure was associated with generally lower HRQoL scores in univariate analysis, with statistically and clinically significant reductions in 3 subscale scores: role physical, emotional well-being and role emotional.¹²

DISCUSSION

The systematic review from this study showed SHS exposure was significantly associated with poorer scores on almost all domains of HRQoL, especially in physical and mental components. The negative effects of SHS exposure on physical health in never smokers are unwell-known. Studies that examined the association between SHS exposure and physical functioning were mostly restricted to patient samples with inconclusive findings.¹

Meanwhile, the pathways by which SHS is linked to poor mental health are not sufficiently understood and likely vary.¹³ The relationship between

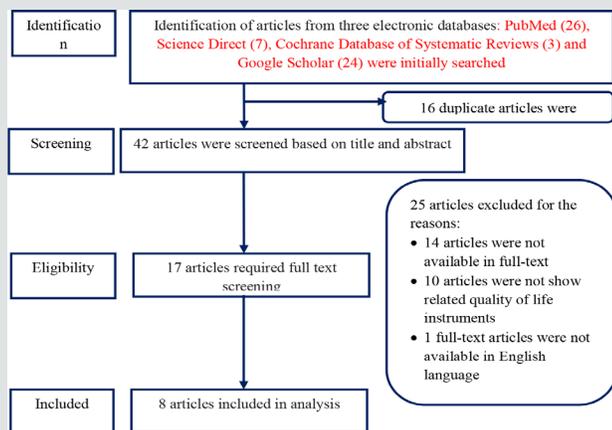


Figure 1: PRISMA diagram of retrieved studies.

Table 1: Data extraction of research on secondhand smoke (SHS) exposure and HRQoL

Author, year	Participants (country) and design	Secondhand smoke measurement	QoL instruments	Results	QoL scores
Bridevaux <i>et al.</i> 2007 ⁶	Never smoking adults aged 18 to 60 years (Switzerland). Cross-sectional study (n 2,500).	SHS exposure: "Have you been regularly exposed to tobacco smoke in the last year?" [yes]. Place of exposure: "Have you been regularly exposed to tobacco smoke at home/your workplace/ in bars or restaurants during the last 12 months? [yes/no]. SHS duration/level: Groups: 0 h/d (reference group), 3 h/d or less (moderate exposure) and more than 3 h/d (high exposure)	SF-36 with 8 domains (physical functioning, role physical, bodily pain, general health, vitality, social functioning, role emotional and mental health).	High SHS exposure has a greater reduction in HRQoL. In women, exposure to SHS at home was associated with a stronger negative effect on HRQoL than at work and in public spaces. Exposed men had lower scores for the role physical domain (-20.0, P< 0.001) and a trend toward lower scores in other domains.	Scores on the physical functioning (-7.8, P < 0.001), role physical (-10.5, P = 0.02), bodily pain (-9.2, P = 0.01) and social functioning (-8.1, P=0.007) domains.
Weeks <i>et al.</i> 2011 ¹²	Current nonsmokers (never smoking or ex-smokers who quit >2 years ago) adult with heart failure (San Francisco). Cohort study (n 205).	SHS exposure: persons with a high-sensitivity assay for urinary cotinine level. Place of exposure: at home/ workplace/ public places. SHS duration/level: "How many hours per week are you exposed to other people's tobacco smoke?" [levels of 0, 1-9, 10 - 39 and >40 h weekly]	SF-36 which assesses 8 domains as above.	Exposure to SHS was associated with generally lower HRQoL scores in univariate analysis. Clinically significant reductions in 3 subscale scores: role physical, emotional well-being and role emotional.	Reductions in 3 subscale scores: role physical (22.2 points P = 0.003), emotional well-being (11.0 points P = 0.001) and role emotional (16.2 points P = 0.03)
Chen <i>et al.</i> 2015 ¹	Never smoking adult aged above 18 (Hongkong). Cross-sectional study (n 6,050).	SHS exposure: Have you been exposed to SHS by any chance?" [yes]. Place of exposure: multiple choice of locations of SHS exposure were recorded including: one's own home, friends' homes, outdoor areas of the workplace, public leisure places and other public places.	SF-12 Health Survey Questionnaire with 8 domains as above	Those exposed to SHS in indoor public places had lower scores on most SF12 domains and physical and mental. SHS exposure in one's home and workplace was associated with lower scores on role physical, body pain and role emotional. SHS exposure in friends' homes was additionally associated with lower social functioning and mental health scores.	Physical Component Scale (PCS) (regress coefficient = -0.76, 95% CI -1.34 to -0.17) and Mental Component Scale (MCS) (regress coefficient = -1.35, 95% CI -2.06 to -0.64) were lower in those with SHS exposure than those non-exposed.

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Kim <i>et al.</i> 2015 ⁷	Never smoking adult (South Korea). Cross-sectional study (n 10,532).	SHS <i>place/duration</i> : "If you are regularly exposed to cigarette smoke at your workplace/home how many hours per day are you exposed?" [Unexposed, <2 h and >2 h per day].	EQ-5D index with five dimensions: mobility, self-care, usual activities, pain/ discomfort and anxiety/depression. EQ-VAS score	Exposure to SHS was significantly associated with lower measures on the EQ-5D index and EQ-VAS score. When comparing the unexposed group with the groups exposed <2h/day and >2h/day, exposure to a longer duration of SHS was significantly associated with lower scores on the EQ-5D index and the EQ-VAS score	Compared to the unexposed group, the group exposed to SHS had significantly lower adjusted means of EQ-5D index (0.929 vs. 0.923, P= 0.022) and EQ-VAS score (73.517 vs. 71.648, P<0.001)
Kim <i>et al.</i> 2016 ⁹	Non-smoking wagedworkers aged more than 15 years (Korea). Logistic analysis (n 19,879).	<i>Place/duration of exposure</i> : "Are you currently exposed to cigarette smoke by other people at work?" [Seven-point scale answer, participants were categorized SHS exposed for ¼ or more of the working hours and non-exposure never exposed/almost never exposed].	WHO-Five Well-Being Index (1998 version)	Poor psychological well-being was significantly higher for SHS exposure group compared to non-exposure group.	The unadjusted OR of poor psychological well-being with OR: 1.594, 95 % CI: 1.421 - 1.787 and OR: 1.330, 95% CI: 1.178 -1.502 after adjusted.
Tran <i>et al.</i> 2015 ¹¹	Nationwide middle-aged and older adults that have been following for eight years from 2005–2013 for emerging chronic diseases (Thailand). Longitudinal analysis (n 87,151).	<i>SHS exposure</i> : Asked if they were exposed to smoke at home, in a recreational place, in the workplace, at public transport station [yes]. <i>SHS level</i> : Classified into 4 different smoking groups: 1) control group (non-exposure); 2) passive smokers; 3) former smoker; 4) current smoker.	SF-8 or psychological distress (Kessler 6)	Wellbeing amongst passive smokers was apparent even after nearly a decade of follow-up.	Psychological distress were found amongst those reporting exposure to ETS at the workplace (OR = 1.27, 95 % CI 1.18-1.36) and at home (OR = 1.21, 95 % CI 1.12 - 1.30) For males, psychological distress 8 years later increasing (OR) = 1.76, 95 % CI 1.24-2.48).
Sobotova <i>et al.</i> 2011 ⁸	Non-smoking mothers with children <18 years (USA). Bivariable and multivariable analyses (n 18,810)	<i>SHS exposure</i> : Administered Questionnaire administered to all household members aged 18 years or greater, which participants are instructed to return by mail. One of the questions is "Do you smoke?".	SF-12 with Physical Component Scale (PCS) and Mental Component Scale (MCS)	The presence of an adult smoker and increasing number of smokers in the home are both negatively associated with MCS and PCS scores in bivariable analyses. A previously unrecognized child health risk: living with smokers is independently associated with worse physical and mental health among nonsmoking mother.	Among non-smoking mothers, the mean MCS score is 50.5 and mean PCS is 52.9. Non-smoking mothers with at least one smoker in the household had an 11 % (95% CI= 0.80 - 0.99) lower odds of MCS score and a 19% (95% CI= 0.73 - 0.90) lower odds of scoring at PCS compared to with no smokers in the household

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Table 1: Cont'd.

<p>Eisner <i>et al.</i> 2009¹⁰</p>	<p>Adult aged 40 – 65 years that recently treated for COPD (Northern California). Cohort study (n 809)</p>	<p><i>SHS exposure:</i> instrument ascertains exposure during the past seven days: the respondent's home, another person's home, traveling in a car or another vehicle, workplace, other places.</p> <p><i>SHS level:</i> no exposure, lower level exposure (up to 1 h/week) and higher level (1 h/week) exposure.</p>	<p>SF-12 Physical Component Summary Score</p> <p>Airways Questionnaire 20-R</p>	<p>SHS exposure appears to increase the risk of adverse health outcomes, including poorer physical health status, HRQoL, exercise capacity and disease exacerbation resulting in emergency health care utilization.</p>	<p>Poorer physical health status (mean score decrement –1.78 points; 95% CI –3.48 - 0.074 points)</p> <p>Composite endpoint of either ED visits or hospitalizations for COPD (HR 1.52; 95% CI 1.06 - 2.18 and HR 1.40; 95% CI 0.94 - 2.10, respectively)</p>
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SHS exposure and mental function is biologically plausible because nicotine is known to affect psycho physiological pathways that are relevant to mental health such as the dopaminergic system,¹ adrenocortical function and activation of neuroimmunological pathways that have been linked to depression.¹⁴ Secondhand smoking has similar physiological effects as firsthand smoking, such as a decrease in hormones and neurotransmitters, thus increasing the risk of depression and suicide.¹⁵ Consequently, nicotine imposes genetic effects on dopamine regulation which are likely to affect depression or anxiety.⁹ Therefore, a multifaceted approach such as institutional measures for prevention of secondhand smoking and improvement of recognition conversion is needed in order to protect the mental health of adolescents.¹⁵⁻¹⁶

In people with disease, previous epidemiologic studies have shown an association between the risk of having a diagnosis of respiratory related diseases such as asthma and COPD and SHS exposure.^{10,17} Lung function of patients with asthma was worse when exposed to SHS.^{6,17} SHS exposure is widespread, contains potent respiratory irritants makes SHS is perceived as a potentially important aggravating factor for adults with respiratory disease. Reflecting this view, national asthma guidelines recommend that people with asthma avoid SHS exposure.¹⁰

In cardiovascular disease, exposure to SHS in humans has been associated with increased white blood cell counts, C-reactive protein, homocysteine, fibrinogen and low density lipoprotein cholesterol levels, all suggesting a generalized increase in inflammatory markers. Inflammation may also play an important role in heart failure outcomes.¹² Physicians should advice patients with heart failure and their families to avoid exposure to SHS. Moreover, the implementation of smoke-free legislations was related to reductions in acute coronary event hospitalizations in most populations evaluated and it's reinforce the urgent need to enact and enforce smoke-free legislations that protect all citizens.¹⁸

SHS has also been already shown to have numerous health consequences to exposed children and woman adults, yet it continues to be a significant problem in the United States. The results of the present study involving a nationally representative US sample demonstrate impaired mental and physical health of non-smoking mothers who live with smokers.⁸ Another study also reported a significant association between SHS exposure and depression among never-smoking Korean women and observed that regular SHS exposure might have a higher risk for depression than occasional exposure.¹⁹

As HRQoL is a comprehensive measurement of physical, social and mental functions⁶ there were also a study reported SHS exposure influence in term of social function. Negative association between SHS at home and family well-being observed in Wang *et al.*²⁰ study, it suggests that family smoking and SHS exposure were linked to poor family well-being, which indicated the adverse effects of SHS on the individual have been expanded to family as a whole. Finally, from all studies we found people who get SHS exposure were significantly associated with lower HRQoL value, even in healthy or for people with diseases.

Several limitations need to be considered in interpreting the findings of this review. First, the variability in secondhand measures and health quality outcome measures reported in each study precluded the possibility of meta-analytic procedures in summarizing the studies. Among the studies, the majority relied on self-report measures and only one study used biomarkers of SHS. As such, we lack the ability to distinguish between the effects of psychosocial aspects of SHS as compared to more biological aspects. Third, differences in the studies may have been affected by unaccounted differences in countries, population groups, policy environments and variable measured. Future studies with randomized controlled designs or fixed effect modeling for longitudinal studies can provide more robust predictions regarding the effect of secondhand smoking on health quality of life.

CONCLUSION

Exposure to SHS was associated with generally lower HRQoL, suggesting that detrimental effects of SHS exposure on HRQoL were not limited to people with diseases (chronic disease, COPD, or heart failure) but also in healthy never smoking children and adult, both in man and woman. Therefore, it can provide new evidence for encouraged to put in stronger smoke-free policies on public places and promoting smoke-free homes,²¹ as the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) recommends comprehensive smoke-free policies to protect people from secondhand smoke.²²

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

ABBREVIATIONS

COPD: Chronic Obstructive Pulmonary Disease; **DALYs:** Disability Adjusted Life Years; **EQ-5D:** Euro-Quality of Life Five Dimensions; **FCTC:** Framework Convention on Tobacco Control; **HRQoL:** Health Related Quality of Life; **PRISMA:** Preferred Reporting Items for Systematic Reviews and Meta-Analysis; **SHS:** Secondhand Smoke; **VAS:** Visual Analog Scale.

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