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Carbon monoxide levels in water pipe smokers in rural Laos PDR

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Regional trends indicate that tobacco waterpipe (TWP) smoking is common in the Eastern Mediterranean Region (EMR) and is increasing in global popularity.[1–4] EMR TWP smokers use a commercially manufactured pipe (figure 1A)[5] that is loaded with tobacco and sold in pre-weighed packages of 50 g or more. The EMR TWP user inhales a combination of tobacco and charcoal smoke after it has passed through water. Despite the mistaken belief that the water bath of the EMR TWP filters out harmful and/or addictive components,[36–8] recent data indicates that EMR TWP smokers are exposed to biologically harmful levels of nicotine, tar, metals, volatile aldehydes, polycyclic aromatic hydrocarbons, volatile organic compounds and expired carbon monoxide (CO).[9]

In the Western Pacific Region, the Asian tobacco water pipe (ATWP, figure 1B) is a homemade pipe that consists of a tube (made of bamboo, clay or PVC material) with a short spout for insertion of loose tobacco. In contrast to the EMR TWP, the ATWP does not use the charcoal. Thus, in ATWP smoking, the source of the CO is the burning tobacco, which is typically about 3–10 g, and it comes from local sources including loose tobacco or tobacco extracted from cigarettes (by qualitative observation (JRL, KS and BM) done in Laos). At present, ATWP smoking has been described in Laos,[10] a survey in Vietnam has identified

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Contributors JRL designed the study, collected the data, analysed the data and wrote the report. PNS designed the study, co-wrote the report, and obtained the funding. KS and BM designed the study, edited the report, and collected the data. RS edited the report. JRL and PNS had principal responsibility in designing the study, collecting data, data analysis and interpretation, and writing of the manuscript. All authors were involved in the review of the final manuscript prior to submission.

Competing interests None.

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4.1 million ATWP smokers,[11] and a 2006 national survey of Cambodia identified an ATWP smoking prevalence of 30–50% in ethnic minorities on the Lao-Cambodia border.[12]

The purpose of our study is to compare the expired CO in ATWP smokers, cigarette smokers and non smokers in rural Laos PDR.

METHODS

In 2010, we selected six villages in a rural district of the Luang Nam Tha province that were known to have a high prevalence of ATWP smokers. A convenience sample of cigarette smokers, water pipe users, and non-smokers were taken through a selection of households (ie, randomly selected from crude base-maps of household blocks generated by study personnel) from each village. The village chief, who knew all of the inhabitants of the village, provided confirmation that a sufficient number of water pipe users lived in the village.

Since we were comparing water pipe smokers, cigarette smokers and non-smokers on CO and lung function (forced expiratory volume in one second and forced vital capacity are considered in another report), we needed to account for the strong confounders of lung function such as age and gender. We did this by studying men who were 40 years and older. This was also done since smoked tobacco (cigarettes or water pipe) is primarily a habit of men in Laos. Thus, our selection criteria resulted in a sample of men 40 years and older who could complete the respiratory health testing. We had an overall response rate of 98% with a final sample of 101 subjects (46 cigarettes, 20 ATWP, 8 mixed and 27 non-smokers). Of the 101 subjects, 99 completed all of the respiratory health testing. Informed consent was obtained from all subjects and ethics approval was obtained from the Ethics Committee of the Ministry of Health Vientiane Capital and the Institutional Review Board of Loma Linda University.

All CO testing was conducted using a portable, battery-operated Micro 4 Smokerlyzer CO meter (Bedfont, UK). Subjects also completed a physical examination, salivary cotinine test and an interviewer administered survey.

RESULTS

Of the 99 men studied, (mean age, 52 years) we found that cigarette smokers averaged about 12 cigarettes per day (SD=7). ATWP smokers averaged 10.6 (SD=7) pipe wads (about 30 g per wad) of loose tobacco per day. Tobacco smokers averaged 28 years (SD=10) of tobacco use during their lifetime. CO testing was completed between 09:00 to 12:00 on each day of the study, and on average it was 15 min after the smokers had smoked either cigarettes or an ATWP.

The mean (±SD) expired CO levels (ppm) were as follows: 10.46±6.98 for cigarettes only, 8.62±5.08 for ATWP only, 5.62±5.36 for mixed users and 2.57±1.59 for non-smokers. Analysis of variance indicated that when compared with non-smokers, the CO levels in men who smoked cigarettes only ($p<0.0001$) or ATWP only ($p<0.002$) were significantly higher. No significant difference ($p=0.60$) was found between ATWP smokers and cigarette smokers. These findings remained in regression models with covariates for age, BMI, indoor cooking fires and ethnicity.

DISCUSSION

In a sample of rural men from Laos PDR, we found that ATWP smokers (figure 1B) had expired CO levels that were significantly higher ($p<0.002$) than non-smokers and similar to

cigarette smokers (p=0.60). The absence of charcoal in the ATWP (as compared with EMR TWP) does not appear to reduce CO to a level that is significantly less than cigarettes. Similar to the EMR TWP, the water in the ATWP does not appear to reduce important CO exposure that can potentially reduce oxygen delivery. Further studies of the health effects of the ATWP are needed. The ATWP needs to be included in global tobacco control and prevention efforts.

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What this study adds

- A common belief among water pipe smokers is that this behaviour is harmless due to the misperception that water `filters' the tobacco smoke. Previous studies of the manufactured water pipe in the Eastern Mediterranean Region do not support this belief and indicate that carbonmonoxide (CO) exposure in water pipe smokers is at least comparable with cigarettes and, in sufficient amounts can be toxic.
- In Asia, a homemade water pipe (ie, bamboo) is commonly used by ethnic groups living throughout the Western Pacific Region. The health effects of this homemade waterpipe have not been studied. We provide the first estimate of CO exposure among the homemade waterpipe users of rural Laos and compare these levels with cigarette smokers and non-smokers from the same community. We found that CO levels in these water pipe smokers are as high as cigarette smokers and significantly higher than non-smokers.

Figure 1.
(A) Eastern mediterranean tobacco waterpipe (left), (B) Asian tobacco waterpipe (right).