Original Article

Tobacco Smoking Status as Assessed by Oral Questionnaire Results 30% Under-reporting by Adult Males in Rural India: A Confirmatory Comparison by Exhaled Breath Carbon Monoxide Analysis

Pradeep Aggarwal, Saurabh Varshney[1], Sunil D. Kandpal, Divya Gupta[2]

Departments of Community Medicine and [2]Anaesthesiology, Himalayan Institute of Medical Sciences, Dehradun, [1]Department of Otorhinolaryngology, All India Institute of Medical Sciences, Rishikesh, Uttarakhand, India

Abstract

Background: The authenticity and true status of tobacco use, especially in the form of smoking among the patient clientele is always a matter of concern for their physicians. **Objectives:** The purpose of this study was to assess the authenticity of self-reported habit of tobacco smoking among a population sample of male respondents in rural India. **Methods:** Respondents were asked to complete oral questionnaires that assessed their status of tobacco smoking (if any) as well as duration of tobacco smoking, type of tobacco smoking, and frequency of tobacco smoking. Subsequently, exhaled breath carbon monoxide analysis was performed to detect their amounts of exhaled carbon monoxide. **Results:** In 175 respondents, the Smoke Check color indicators were significantly different ($P < 0.0001$) in the respondents who were diagnosed smokers per oral questionnaires ($n = 92$) versus diagnosed nonsmokers per oral questionnaires ($n = 83$). The probability statistics of authenticity of oral questionnaires for assessing smoking status showed that self-reporting was only 75% sensitive and 76% specific with 80% positive predictive value and 70% negative predictive value. **Conclusion:** True status of tobacco smoking with exhaled breath carbon monoxide analysis can be an easy clinical maneuver with community health screening and health promotion implications among patient populations in rural India.

Keywords: Oral questionnaire, smoking, tobacco

Introduction

The authenticity and true status of tobacco use, especially in the form of smoking among the patient clientele is always a matter of concern for their physicians. Assessing a true status of smoking is important for physicians in regards to initiation, maintenance and successful completion of smoking cessations programs.[1] In addition, it can be helpful for appropriate antenatal care and fetal wellbeing's monitoring in pregnant patients[2,3] who may hesitate to truly state their habits, use and abuse of tobacco smoking. Moreover, knowledge of true status of tobacco smoking can guide the anesthesiologists[4] in the preoperative assessment of tobacco smokers, wherein the perioperative pulmonary complications can be directly related to the presence, duration and grading of tobacco smoking abuse. Finally, the true status of tobacco use can help the administrators[5] to effectively implement the smoking cessation and health promotion programs among their students, their employees as well as general population in question. Exhaled carbon monoxide analyzers[1-5] have been used for the true status assessment of tobacco smoking. Besides the utility in tobacco smoking abuse, extremely high levels of detected carbon monoxide by these analyzers give an additional indication for potential carbon monoxide poisoning that can be secondary to undetected home environments or occupational environments related exposures to carbon monoxide.[6-8]

Even though, awareness toward hazards of smoking is increasing among common masses, individuals find it difficult to quit their years' old habit of smoking. The use of Smoke Check meter for analysis of exhaled breath carbon monoxide is the need of hour so that such cases can be repeatedly motivated through counseling sessions and cross checked by Smoke Check meter

Access this article online

Quick Response Code:

Website: www.jfmpc.com

DOI: 10.4103/2249-4863.141606

Address for correspondence: Dr. Pradeep Aggarwal, Department of Community Medicine, Himalayan Institute of Medical Sciences, Swami Ram Nagar, P.O. Doiwala, Dehradun - 248 140, Uttarakhand, India. E-mail: drpradeep_aggarwal@hotmail.com

until the time the individual is able to quit smoking for his/her health benefits.

The purpose of the current study was to assess the authenticity of self-reported habit of tobacco smoking among a population sample of male respondents in Rural India.

Methods

After institutional review board approval and written informed consent, 205 respondents who had presented as personal caregivers for patients at an academic university hospital in rural India, were invited to enroll in this prospective correlation study. After taking informed consent, principal investigator who is a community medicine physician, asked these respondents to complete oral questionnaires that assessed their status of tobacco smoking (if any) as well as duration of tobacco smoking (in years), type of tobacco smoking (bidi that is a traditional Indian cigarette vs. standard cigarette) and frequency of tobacco smoking (number of bidis/cigarettes per day). Other recorded parameters were respondents' age and their occupational history to rule out potential contributions of environmental exposure to carbon monoxide in occupations known to have high risk of carbon monoxide exposure and poisoning. Subsequently, the respondents were explained the method of carbon monoxide breath analysis by Smoke Check, Cardinal Health, Chatham, Kent, UK, as shown in Figure 1 that was provided free-of-cost to the academic university hospital by Cipla, Mumbai, India, for research purposes.

Smoke Check meter was allowed to reach room temperature prior to use. Mouthpiece adapter with disposable mouthpieces that have unidirectional valve were used to prevent cross-contamination between the respondents. Subsequently, Smoke Check was allowed to equilibrate to ambient carbon monoxide levels. Once the unit was ready, the respondent was asked to hold breath for 20 s with Smoke Check buzzing at the end of countdown from 20 to 0. This 20-s delay was to allow the equilibration of respondents' alveolar carbon monoxide levels with circulating carboxyhemoglobin levels in blood. If the respondents were not able to hold their breath for 20 s, they were allowed to exhale in the meter earliest at the end of 12 s when the auto-zero function of the Smoke Check had been completed. After the countdown (usual duration 20-s, but minimum 12-s), the respondents were asked to seal the mouthpiece with their lips followed by slow, but complete exhalation so that Smoke Check could read their exhaled carbon monoxide levels. These levels were detected as colored indicators that are explained in Table 1.

Figure 1: Smoke Check meter used in the current study (Cardinal Health, Chatham, Kent, UK)

After the completion of data collection, the responses to oral questions were statistically analyzed by investigator (blinded to either data acquisitions) for the presence of authenticity of tobacco smoking among the respondents correlation as indicated by the objective and confirmatory test results of Smoke Check. Chi-square test and Fisher exact test with contingency tables was applied for comparing proportions. ANOVA test was applied for comparing continuous data. Probability statistics with likelihood ratios (LRs) (with 95% confidence limits) were analyzed with the help of online VassarStats (Richard Lowry©, 1998-2014, United States).[9] $P < 0.05$ was considered as significant.

Results

A total of 205 respondents consented for the study. There was incomplete data collection in 30 respondents primarily due to inability to appropriately perform the breath analysis tests. A final statistical analysis was performed in the remaining 175 respondents. There was no significant difference in the respondents' age across the various Smoke Check color indicators groups as shown in Table 2. The Smoke Check color indicators

Table 1: Interpretations of smoke check meter readings (Cardinal Health, Chatham, Kent, UK)

Color coded indicator on smoke check meter	Corresponding carbon monoxide measured in exhaled breath (parts/million)	Corresponding level of cigarette consumption
Green	0-6	Nonsmoker
Amber	7-10	Light smoker
Red	11-20	Heavy smoker
Red+Alarm	>20	Very heavy smoker

Table 2: Comparison of respondents' ages included in the study

Smoke check indicator (*n*=175)	Age of the smokers (per oral questionnaire) in years (mean±SD) (*n*=92)	Age of the nonsmokers (per oral questionnaire) in years (mean±SD) (*n*=83)	*P* value (significant if <0.05)
Green (*n*=76)	37±15.29	34.5±12.08	0.47
Amber (*n*=35)	42.57±14.27	39.29±10.25	0.46
Red (*n*=51)	44.31±13.08	41.67±8.80	0.57
Red+Alarm (*n*=13)	43.45±12.60	46.5±9.19	0.76

SD: Standard deviation

were significantly different ($P < 0.0001$) in the respondents who were diagnosed smokers per oral questionnaires versus diagnosed nonsmokers per oral questionnaires as shown in Table 3. There was no significant effect of the potential occupational exposure to carbon monoxide among smokers ($P = 0.76$) as well as nonsmokers ($P = 0.079$); however, the P value was much lower among nonsmokers than among smokers suggesting that potential occupational exposure to carbon monoxide may have affected our results (without reaching the level of statistical significance) primarily for the respondents who were nonsmokers as shown in Table 4. The duration of tobacco abuse was not compared as majority of respondents did not remember their actual durations of abuse. After excluding the four respondents who smoked both bidis and cigarettes, the smoke check color indicators groups for smokers were compared for the amount/frequency of tobacco smoking. It was determined that the gradually increasing number of bidis/cigarettes consumed per day reflected in the higher grades (Green to Amber to Red) of Smoke Check color indicators that was statistically significant ($P = 0.04$ for bidis consumers vs. $P = 0.0006$ for cigarettes consumers) as shown in Table 5. The low number of smokers in Red with Alarm indicator groups and ambiguity of the number of bidis/cigarettes consumed by these respondents precluded their inclusion in the final statistical analysis as shown in Table 5. The probability statistics of authenticity of oral questionnaires for assessing smoking status showed that self-reporting was only 75% sensitive and 76% specific with 80% positive predictive value and 70% negative predictive value when compared with the confirmatory Smoke Check meter results as shown in Table 6. This means that respondents who were nonsmokers per oral questionnaires either under-reported their smoking status with maximum under-reporting level 30% (1-negative predictive value) or were potentially exposed to high carbon monoxide at their occupations or homes. In our respondents' pool, there were only a total of 12 respondents who were exposed to potentially high carbon monoxide levels at their occupations (painter, driver, mill worker, police inspector, welding employee, sewer worker, mechanic, and fabrication worker) but this did not confound our results significantly as shown in Table 4 suggesting under-reporting by the respondents about their tobacco smoking status as the primary underlying cause for our study results. Although, the LRs were not very far removed from equivocal number 1 (the best results for LRs are >5 and <0.2 for positive test LR+ and negative test LR− respectively), still the LRs for the current study were good enough (LR+ =3.16; LR− =0.33), which are interpreted as following:

a. When the respondent had said "I am smoker", it was 3.16 times more likely to have nonGreen indicator versus green indicator on confirmatory Smoke Check meter
b. When the respondent had said "I am nonsmoker", it was 0.33 times more likely to have nonGreen indicator versus green indicator on confirmatory Smoke Check meter.

Table 3: Correlation between the smoke check readings and oral questionnaires of all respondents

Smoke check indicator (*n*=175)	Smokers diagnosed per oral questionnaire (*n*=92)	Nonsmokers diagnosed per oral questionnaire (*n*=83)	*P* value (significant if <0.05)
Green (*n*=76)	18	58	<0.0001
Amber (*n*=35)	21	14	
Red (*n*=51)	42	9	
Red+Alarm (*n*=13)	11	2	

Table 4: Effect of coexistent potential occupational exposure to carbon monoxide and its effects on the smoke check readings

Smoke check indicator	Smokers with coexistent potential occupational exposure to carbon monoxide (*n*=6)	Smokers without coexistent potential occupational exposure to carbon monoxide (*n*=86)	*P* value (significant if <0.05)
Green	1	17	0.76
Amber	2	19	
Red	2	40	
Red+Alarm	1	10	
Smoke check indicator	**Nonsmokers with coexistent potential occupational exposure to carbon monoxide (*n*=6)**	**Nonsmokers without coexistent potential occupational exposure to carbon monoxide (*n*=77)**	***P* value (significant if <0.05)**
Green	2	56	0.079
Amber	3	11	
Red	1	8	
Red+Alarm	0	2	

Discussion

Policies for health promotion at large and smoking cessation programs at individual levels requires authentic self-reporting and recognition of tobacco abuse as personal and major risk factor that is related to many preventable or modifiable diseases including but not limited to cardiac diseases, pulmonary disorders, and cancers. The objectivity of exhaled breath carbon monoxide analyzers provides this opportunity to both tobacco abusers as well as their treating physicians. These treating physicians encompass various patient caregiving fields including but not limited to community medicine, public health, anesthesiology, primary care, family medicine, internal medicine, obstetrics, occupational medicine, and adolescent health. These monitors additionally instill awareness among the sworn-nonsmokers, wherein the high levels of exhaled breath carbon monoxide will be related to unintentional exposures to carbon monoxide at their homes and/or occupations.[6-8]

Even though, our study did not investigate with the respondents about their reasons for under-reporting, the potential reasons for under-reporting are "very light smoking," already trying to

Table 5: Quantitative bidi or cigarette smoking among smokers and its correlation with smoke check readings (four respondents excluded who were combo smokers)

Smoke check indicators	Number of bidis per day (mean±SD) (*n*=60)	Number of cigarettes per day (mean±SD) (*n*=28)	*P* value (significant if <0.05)
Smokers with Green indicator	6.33±6.86 (*n*=6)	2.23±2.03 (*n*=11)	0.08
Smokers with Amber indicator	12.1±5.13 (*n*=10)	8.6±5.13 (*n*=10)	0.14
Smokers with Red indicator	15.64±9.16 (*n*=36)	12.5±6.46 (*n*=4)	0.51
Smokers with Red+Alarm indicator	16.13±4.09 (*n*=8)	6.67±4.73 (*n*=3)	0.0093
P value (significant if <0.05)	0.05 (between all bidi-smokers with either of the four indicators)	0.0016 (between all cigarette smokers with either of the four indicators)	
P value (significant if <0.05)	0.04 (between bidi-smokers with either of Green or Amber or Red indicators)	0.0006 (between cigarette smokers with either Green or Amber or Red indicators)	

SD: Standard deviation

Table 6: Probability of oral questionnaire's reliability as screening tool for cigarette smoking

Oral questionnaire as screening tool with smoke check as confirmation tool	Indicator green on smoke check meaning confirmed nonsmoker (condition absent)	Indicator nongreen on smoke check meaning confirmed smoker (condition present)	Total
Smoker per oral questionnaire (test positive)	18	74	92
Nonsmoker per oral questionnaire (test negative)	58	25	83
Total	76	99	175
Statistical test	Estimated value	Lower limit 95% CI	Upper limit 95% CI
Prevalence %	57	49	64
Probability of any test result being positive %	53	45	60
Probability of any test result being negative %	47	40	55
Sensitivity %	75	65	83
Specificity %	76	65	85
Positive predictive value %	80	71	88
Negative predictive value %	70	59	79
Conventional likelihood ratio for positive test	3.16	2.07	4.80
Conventional likelihood ratio for negative test	0.33	0.23	0.47
Prevalence weighted likelihood ratio for positive test (positive posttest odds)	4.11	2.68	6.30
Prevalence weighted likelihood ratio for negative test (negative posttest odds)	0.43	0.31	0.60

CI: Confidence interval

quit, concerns about social desirability, fear of repercussions, and simple obstinacy to lie.[10] Although the exhaled breath carbon monoxide meters are considered reliable for assessing tobacco smoking, the only primary controversy related to them is the cut-off point for judging smoking status. Like most meters, Smoke Check that we used for our study has a cut-off of 6 parts per million of carbon monoxide as the cut-off point for the diagnosis; however some authors have used cut-off of 10 parts per million.[11]

In India, especially in rural areas, people prefer to smoke bidis[12,13] and this reflects in our study results too with 68% respondents being bidi-smokers and 32% respondents being cigarette smokers. Even though, it had been reported that bidi-smoking create more carbon monoxide levels in the smokers,[14,15] our results in Table 5 suggest that when compared to bidi consumption, lower numbers of cigarette consumption reach the equivalent levels of Smoke Check color indicators; however, these lower numbers did not reach levels of significance secondary to insufficient power of the analysis and small sample size.

There were some limitations in the study. The question about time since last bidi-cigarette smoke[7] was not asked from the respondents that might have explained some smokers showing green indicator on Smoke Check. Due to half-life of carboxyhemoglobin (about 5 h during sleep and much less after physical exercise), sometimes it has been recommended to perform presmoking breath analysis followed by postsmoking breath analysis within 10 min after last smoke.[7] As all the readings for exhaled breath analysis were performed in the prenoon hours, the comparative analyses among the respondents were not confounded. Although it has been recommended to perform exhaled breath analysis during afternoons to avoid the misleading low levels detected in the early morning checks for carbon monoxide that would have fallen due to its half-life during the sleep, high levels of carbon monoxide detected in morning checks for carbon monoxide indicate strong and high tobacco smoking dependence.[7] Hence, our method of prenoon checks for carbon monoxide may have contributed to some of the false positives (smoker per questionnaire, but green indicator per Smoke Check meter). The confrontation question about the reason of under-reporting was not asked from the respondents who showed nonGreen indicator on Smoke Check even though they had said that they were nonsmokers. Moreover, this posttest investigation would have delineated some respondents' potential exposure to carbon monoxide in their home or occupation environments[7] if they would have adamantly denied tobacco smoking in the posttest questioning.

Moreover, since this equipment is very cost-effective, its use at a larger scale, that is, at primary health care level will go a long way in assisting the Indian Tobacco Control Initiative COTPA Act 2003 and bring about a Tobacco Free Society.

Conclusion

In summary, true status of tobacco smoking needs to be assessed at various stages of patient caregiving, and exhaled breath carbon monoxide analysis can be an easy tool to this aim with easy provisions and acceptability among the patient populations that we as physicians cater to in rural India.

Acknowledgment

The authors duly acknowledge the financial assistance (10,000 INR) provided by HIHT University for carrying out this research study.

The authors are thankful to the pharmaceutical company "CIPLA India Pvt. Ltd.," for providing us the Smoke Check meter used in the current study on loan basis which was indeed a great help in successfully completing this study.

Last but not the least, we are thankful to Deepak Gupta, MD, Anesthesiologist, Detroit Medical Center/Wayne State University, Detroit, Michigan, United States who guided us with regards to the application of statistical tests and assisted us in copyediting the final manuscript.

References

1. Bittoun R. Carbon monoxide meter; the essential clinical tool: The 'Stethoscope'- of smoking cessation. J Smok Cessat 2008;3:69-70.
2. Secker-Walker RH, Vacek PM, Flynn BS, Mead PB. Exhaled carbon monoxide and urinary cotinine as measures of smoking in pregnancy. Addict Behav 1997;22:671-84.
3. Secker-Walker RH, Vacek PM, Flynn BS, Mead PB. Smoking in pregnancy, exhaled carbon monoxide, and birth weight. Obstet Gynecol 1997;89:648-53.
4. Shi Y, Ehlers S, Hinds R, Baumgartner A, Warner DO. Monitoring of exhaled carbon monoxide to promote preoperative smoking abstinence. Health Psychol 2013;32:714-7.
5. Hung J, Lin CH, Wang JD, Chan CC. Exhaled carbon monoxide level as an indicator of cigarette consumption in a workplace cessation program in Taiwan. J Formos Med Assoc 2006;105:210-3.
6. Health and Safety Executive Guidance Note EH43: Carbon Monoxide. London: Health and Safety Executive; 1984.
7. DEV.ERSNET.org. European Respiratory Society Buyers' Guide to Respiratory Care Products c2013, Kendrick AH. Exhaled carbon monoxide devices in smoking cessation: physiology, controversies and equipment [about 1 screen]. Available from: http://www.dev.ersnet.org/uploads/Document/e1/WEB_CHEMIN_2567_1194523664.pdf. [Last updated on2007; Last cited on 2013 May 13].
8. Carbon-Monoxide-Survivor.com. Carbon Monoxide Survivor c2008-2012, Carbon monoxide exposure and poisoning: high risk occupations [about 1 screen]. Available from: http://www.carbon-monoxide-survivor.com/carbon-monoxide-exposure-poisoning-high-risk-occupations.html. [Last updated on 2012; Last cited on 2013 May 13].
9. VASSARSTATS.net. VassarStats: Website for Statistical Computation, c1998-2013. Available from: http://www.vassarstats.net. [Last updated on2012; Last cited on 2013 May 13].
10. Stein LA, Colby SM, O'Leary TA, Monti PM, Rohsenow DJ, Spirito A, *et al.* Response distortion in adolescents who smoke: A pilot study. J Drug Educ 2002;32:271-86.
11. Sato S, Nishimura K, Koyama H, Tsukino M, Oga T, Hajiro T, *et al.* Optimal cutoff level of breath carbon monoxide for assessing smoking status in patients with asthma and COPD. Chest 2003;124:1749-54.
12. Chaudhry K, Rath GK. Multisectoral and intersectoral approach to national tobacco control. Paper Commissioned by the World Health Organization on the occasion of the WHO International Conference on Global Tobacco Control Law: Towards a WHO Framework Convention on Tobacco Control. New Delhi, India;2000 Jan 7-9.
13. Prasad R, Ahuja RC, Singhal S, Srivastava AN, James P, Kesarwani V, *et al.* A case-control study of bidi smoking and bronchogenic carcinoma. Ann Thorac Med 2010;5:238-41.
14. Watson CH, Polzin GM, Calafat AM, Ashley DL. Determination of tar, nicotine, and carbon monoxide yields in the smoke of bidi cigarettes. Nicotine Tob Res 2003;5:747-53.
15. Kumar R, Prakash S, Kushwah AS, Vijayan VK. Breath carbon monoxide concentration in cigarette and bidi smokers in India. Indian J Chest Dis Allied Sci 2010;52:19-24.

How to cite this article: Aggarwal P, Varshney S, Kandpal SD, Gupta D. Tobacco smoking status as assessed by oral questionnaire results 30% under-reporting by adult males in rural India: A confirmatory comparison by exhaled breath carbon monoxide analysis. J Fam Med Primary Care 2014;3:199-203.

Source of Support: Financial assistance (10,000 INR) provided by HIHT University (our institute) for carrying out this research study. The Pharmaceutical Company "CIPLA India Pvt. Ltd." provided us the Smoke Check meter used in the current study on loan basis. **Conflict of Interest:** None declared.