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Short Communication

Assessment of second-hand smoke exposure on pulmonary function using IOS and DLCO and its association with health-related quality of life in healthy female college students

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Abstract

Background: According to the World Health Organization, Second-Hand Smoking (SHS) is causing 1.2 million deaths annually. This cross-sectional study aimed to assess the SHS impact on pulmonary functions and Health- Related Quality of Life (HRQOL) among healthy, non-smoking female, and to determine whether SHS may cause harmful effects.

Materials and Methods: Using surveys, *HRQOL*, and *Pulmonary function tests* to compare SHS-exposed vs. non-exposed groups.

Results: SHS linked to reduced *FVC%* and higher *R5–R20*, which can suggest small airway involvement; while HRQOL unaffected.

Conclusion: Second-hand smoke exposure may impair lung function in healthy non-smoking females, particularly affecting FVC% and Z5%, with signs of early small airway involvement.

Keywords: Pulmonary function test, Second-hand smoking, Passive smoking, Female, Health related quality of life.

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1. Introduction

The smoking prevalence among Saudi adults was 36% for men and 3% for women.[1,2] In addition, a Survey conducted by Ministry of Health of Saudi Arabia found that, 13.7% of adults exposed to tobacco smoke at home.[3] SHS exposure have killed around 2,500,000 non-smokers since 1964.[4] SHS have a 2.1-fold increased the incidence of lung cancer, while their risk of cardiovascular disease and stroke is 1.6 and 1.4 times higher, respectively.[5]

In Saudia Arabia, no previous research has evaluated the impact of passive smoking on HRQOL and pulmonary function using a combination of diffusing capacity of carbon monoxide (DLCO) of the lung, Impulse Oscillometry (IOS), and Spirometry which were only performed on United State (US) flight attendants.[6,7]

By addressing this gap, this study seeks to provide valuable contributions to the understanding of SHS on pulmonary function and HRQOL among non-smoking females at the College of Applied Medical Sciences in Jubail – Imam Abdulrahman bin Faisal University (CAMS-J).

2. Materials and Methods

This is a cross-sectional study from 1 January 2025 to 5 May 2025.

Due to time limitation only 20 participants met the study criteria:

1. 11 participants (control group)
2. 9 participants (exposure group)

2.1. Inclusion criteria

1. Female and 18 years or older.

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2. Non-smokers Members of the College of Applied Medical Sciences- Jubail, Imam Abdulrahman bin Faisal University (CAMS-J).

2.2. Exclusion criteria

1. Exposure to bakhour (> twice a week) (Al Khathlan et al., 2021).
2. Underlying lung disease.
3. Missing data (e.g., incomplete SHS and H RQOL questionnaires, lack of a recent complete blood count [CBC] within six months (Showalter et al., 2018), and/or no response).

2.3. Study outcomes

2.3.1. Primary outcome

Pulmonary function outcomes:

1. Airway resistance and lung compliance measured by Impulse Oscillometry (IOS)
2. Diffusing Capacity measured by Diffusing Capacity of Carbon Monoxide (DLCO) and/or FEV1/FVC)

2.3.2. Secondary Outcome

Health-Related Quality of Life (HRQOL) outcome by questionnaire:

1. Describes the patient's health state in five dimensions (mobility, self-care, usual activities, pain/discomfort, anxiety/depression)

2.4. Pulmonary function testing (PFT)

Participants underwent standardized pulmonary function testing (IOS, DLCO, and spirometry) using calibrated equipment under ATS/ERS guidelines, with repeated trials, strict infection control, and results interpreted against reference values in sessions lasting 30–45 minutes.

2.5. Statistical analysis

Data were analysed using SPSS (v15.0) with descriptive statistics, Mann–Whitney U test, and Spearman's rank correlation to assess associations between SHS exposure, pulmonary function, and HRQOL, with significance set at $p < 0.05$.

3. Results

Table 1: Characteristics of 20 participants [a]

Characteristics	Total	Control group	Exposed group
Number of participants, n (%)	20 (100)	11 (55)	9 (45)
Age, years [Median (IQR)]	[21(22-21)]	[21(22-20)]	[21(22-21)]
Hight, cm [Median (IQR)]	[158(162.75-154.5)]	[160(162-158)]	[156(163-151.5)]
Weight, kg [Median (IQR)]	[50.5(62-42.75)]	[53(63-45)]	[48(61.5-41.5)]
Hemoglobin level, g/dL [Median (IQR)]	[11.55(12.15-10.98)]	[11.5(12.6-11.2)]	[11.9(12.1-10.7)]
Occupational Status n (%)			
• Employee	• Employee= 1 (5)	• Employee= 0	• Employee= 1 (11.1)
• Instructor	• Instructor= 1 (5)	• Instructor= 1 (9.1)	• Instructor= 0
• Student	• Student= 18 (90)	• Student= 10 (90.9)	• Student= 8 (88.9)
Marital Status, n (%)			
• Single	• Single= 16 (80)	• Single= 9 (81.8)	• Single= 7 (77.8)
• Married	• Married= 3 (15)	• Married= 1 (9.1)	• Married= 2 (22.2)
• Other	• Other= 1 (5)	• Other= 1 (9.1)	• Other= 0
Number of hours per day exposed to other people's tobacco smoke [Median (IQR)]	[0(1-0)]	0	[1(2.5-1)]
5Q-5D-5L, n (%)			
Mobility[b]			
MO1	17 (85)	10 (90.9)	7 (77.8)
MO2	3 (15)	1 (9.1)	1 (11.1)
MO3	0	0	1 (11.1)
MO4	0	0	0
MO5	0	0	0
Self-care[c]			
SC1	19 (95)	11 (100)	8 (88.9)

SC2	1 (5)	0	1 (11.1)
SC3	0	0	0
SC4	0	0	0
SC5	0	0	0
Usual Activity[d]			
UA1	18 (90)	10 (90.9)	8 (88.9)
UA2	2 (10)	1 (9.1)	1 (11.1)
UA3	0	0	0
UA4	0	0	0
UA5	0	0	0
Pain / Discomfort[e]			
PD1	16 (80)	7 (63.6)	9 (100)
PD2	4 (20)	4 (36.4)	0
PD3	0	0	0
PD4	0	0	0
PD5	0	0	0
Anxiety / Depression[f]			
AD1	12 (60)	8 (72.7)	4 (44.4)
AD2	7 (35)	2 (18.2)	5 (55.6)
AD3	0	0	0
AD4	1 (5)	1 (9.1)	0
AD5	0	0	0

Table 2: Pulmonary function tests parameters according to SHS exposure [a]

Parameters	**Control group**	**Exposed group**	
	[Median (IQR)]	**[Median (IQR)]**	**P value***
FVC %	[0.88(0.99-0.83)]	[1.02(1.09-0.98)]	0.01*
FEV1 %	[1.04(1.07-0.77)]	[1.06(1.11-1)]	0.26
FEV1/FVC	[0.93(0.96-0.81)]	[0.87(0.94-0.83)]	0.66
PEF %	[0.83(0.9-0.76)]	[0.75(0.9-0.63)]	0.33
Unadjusted DLCO %	[0.8(0.96-0.67)]	[0.76(0.89-0.69)]	0.82
Adjusted DLCO%	[0.86(1-0.73)]	[0.82(0.94-0.75)]	0.88
Z5 %	[1.64(1.78-1.29)]	[1.19(1.46-1.17)]	0.07
R5 %	[1.41(1.71-1.14)]	[1.15(1.44-1.12)]	0.18
X5 %	[-10.7(-8.17- -13.63)]	[-8.34(-6.14- -12.79)]	0.37
R20 %	[1.56(1.66-1.26)]	[1.34(1.62-1.2)]	0.55
R5-R20	[0.07(0.09-0.03)]	[0.04(0.65- -0.02)]	0.18

a Stratified according to secondhand smoking exposure (SHS).
* Mann–Whitney U test used. P value less than 0.05 was statistically significant.

Table 3: Health related quality of life according to SHS exposure [a]

Characteristic	**Control group**	**Exposed group**	**P value***
	[Median (IQR)]	**[Median (IQR)]**	
EQ-VAS	[89(95-80)]	[90(95-85)]	0.66
5Q-5D-5L index value	[1(1-0.9)]	[0.96(1-0.96)]	0.41

* Mann–Whitney U test

4. Discussion

According to our findings, secondhand smoke exposure did not demonstrate a statistically significant relationship with the DLCO (P= 0.88), and similar non-significant associations were observed across all other pulmonary function parameters including spirometry and IOS measures except for FVC% (P= 0.0.01). FVC% clearly showed a strong link between SHS exposure and the reduction of this parameter. Additionally, from all PFT parameters there was a strong and positive correlation between R5-R20 and SHS exposure duration (P= 0.03, rho= 0.72). Similarly, HRQOL levels were not strongly associated with SHS exposure in the examined population. One possible explanation for this might be that the exposure period in the sample was not enough to show remarkable effects.

Our results were in agreement with the findings of a study by Schivinski, regarding FVC%, as they found that there was an absolute reduction in FVC% among SHS exposed group compared to non-exposed group.[8] One study by Gunlemez in 2019), supports our findings in IOS, they found a significant elevation in R5-R20 among SHS group which indicate early sign of small airway resistance.[9]

5. Conclusion

In Conclusion, Second-hand smoke exposure may impair lung function in healthy non-smoking females, particularly affecting FVC% and Z5%, with signs of early small airway involvement also, Future studies is needed with increase sample size to improve statistical power and generalizability and use serum cotinine instead of self-reports for more accurate SHS exposure assessment. Longitudinal designs are also recommended to clarify causality and the long-term effects of exposure.

The limitations of current study in achieving the desired sample size due to exclusion of regular bakhour users and the requirement for recent CBC results for DLCO testing, which some participants lacked. Additionally, the restricted academic semester timeframe and the IOS system's inability to calculate predicted Fres and Ax values further constrained data collection and analysis.

6. Source of Funding

None.

7. Conflict of Interest

None.

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