ORIGINAL ARTICLE

The Impact of Tobacco and Occupational Exposure on Chronic Obstructive Pulmonary Disease in a 70 and over Jamaican Cohort from the Burden of Obstructive Lung Disease (Jamaica) Study

A Aquart-Stewart[1], CA Walters[2], SA White[3]

ABSTRACT

Background: *Chronic obstructive pulmonary disease (COPD) is a chronic respiratory disease predominantly affecting the older population. Not well known, COPD is often confused with asthma. Tobacco smoking is widely acknowledged as the most important risk factor for COPD, but occupational exposures from irritant dust, fumes and, biomass exposures from burning wood and coal indoors, also contribute to COPD prevalence. This paper looks at COPD prevalence and occupational exposures in adults aged 70+ using data from the United Kingdom-based Burden of Obstructive Lung Disease (BOLD) study in Jamaica (www.boldstudy.org).*

Subject and Method: *Jamaica followed a strict BOLD protocol of face to face standardized questionnaire administration and spirometry testing on participants aged ≥ 40 years. Questions included sociodemographic characteristics, smoking practices, respiratory symptoms and occupational exposures. The Occupational questionnaire enquired about time spent in thirteen different occupations including farming, construction, firefighting, domestic and industrial cleaning, welding, coal mining, flour, feed or grain milling to mention a few. Spirometry was performed according to American Thoracic Society (ATS) standards. An island-wide multi-stage random sample of non-institutionalized individuals was selected for recruitment with the assistance of the Statistical Institute of Jamaica (STATIN). All questionnaires and spirometry data from consenting participants were submitted electronically to the United Kingdom Coordinating Centre for data cleaning, quality checks and preliminary analysis. Final data were returned to the local research team for further analysis.*

Result: *Total sample selected for recruitment (and response rate) was 883 (91.4%) for persons aged ≥ 40 years and 190 (87.2%) for persons aged 70+ years. Of the 164 responders in the 70+ group, 91 (55.5%) had usable spirometry. Prevalence of ever-smoking by age and gender in this 70+ cohort was 38.4%. Farming, construction and household cleaning were the most frequently reported occupations (58.8%). Years working in these three occupations ranged from 1–70 (farming and construction) and 1–78 (cleaning). Most were now retired (120 of 164 overall). Weighted estimated population prevalence of Global Initiative for Chronic Obstructive Lung Disease (GOLD) Stage 1 (Post-BD $FEV_1/FVC < 70\%$; $FEV_1 \geq 80\%$ predicted) was 12.1% overall for persons aged 40+, but was highest at 37.8% in the 70+ age group. Estimated prevalence of GOLD Stage 2 ($50 \leq FEV_1 < 80\%$ predicted) was 9.6% in the 40+, again highest at 31.3% in the 70+ age group.*

Conclusion: *Overall prevalence of COPD in the 40+ age group whether Stage 1 (mild COPD), or Stage 2 (moderate COPD), while it appears low, was still highest in the 70+ age group. The local data revealed that whilst the prevalence of current smoking had declined by age 70+, the estimated prevalence of GOLD Stage 1 and Stage 2 COPD was highest in this age group. The*

From: [1]Department of Medicine, Faculty of Medical Sciences, The University of the West Indies, Mona Campus, Jamaica, [2]Health Research Resource Unit, Office of the Dean, Faculty of Medical Sciences, The University of the West Indies, Mona Campus, Jamaica and [3]Clinical Research Centre, Office of the Dean, Faculty of Medical Sciences, The University of the West Indies, Mona Campus, Jamaica.

Correspondence: Dr A Aquart-Stewart, Department of Medicine, Faculty of Medical Sciences, The University of the West Indies, Mona Campus, Jamaica. Email: althea.aquartstewart@gmail.com

DOI: 10.7727/wimj.2018.185

contribution of occupational exposures to the development of COPD, requires further analysis to look at the occupational exposures across all participants aged 40+ as well as the prevalence of COPD among non-smokers. Progression of Stage 1 to Stage 2 disease and its effect on morbidity and quality of life is likely without patient education regarding complications of tobacco smoke and workplace exposures to the development of COPD.

Keywords: Burden of obstructive lung disease, chronic obstructive pulmonary disease, Jamaica, occupation, tobacco

Impacto del Tabaco y la Exposición Ocupacional en la Enfermedad Pulmonar Obstructiva Crónica en una Cohorte Jamaicana de 70 ó Más Años de Edad del Estudio de la Carga de la Enfermedad Pulmonar Obstructiva (Jamaica)

A Aquart-Stewart[1], CA Walters[2], SA White[3]

RESUMEN

Antecedentes: *La enfermedad pulmonar obstructiva crónica (EPOC) es una enfermedad respiratoria crónica que afecta predominantemente a la población de personas mayores. Como no se la conoce bien, la EPOC se confunde a menudo con el asma. El tabaquismo es ampliamente reconocido como el factor de riesgo más importante de la EPOC, pero las exposiciones profesionales a polvos irritantes, humos y gases, así como las exposiciones a la biomasa de leña y carbón en espacios cerrados, contribuyen a la prevalencia de la EPOC. El presente trabajo examina la prevalencia de la EPOC y las exposiciones ocupacionales en adultos de 70+ años, utilizando en Jamaica datos del estudio de la Carga de la Enfermedad Pulmonar Obstructiva (BOLD, en inglés) con base en el Reino Unido (www.boldstudy.org).*

Sujetos y método: *Jamaica siguió un estricto protocolo de BOLD consistente en administrar cara a cara cuestionarios estandarizados y pruebas de espirometría a participantes de ≥ 40 años de edad. Las preguntas incluyeron características sociodemográficas, prácticas de tabaquismo, síntomas respiratorios y exposiciones ocupacionales. El cuestionario ocupacional indagó sobre el tiempo transcurrido en trece ocupaciones diferentes, incluyendo trabajo en el campo (agricultura, cría de animales) construcción, extinción de incendios, limpieza doméstica e industrial, soldadura, minería de carbón, y molienda de harina, piensos o granos, por mencionar algunas. La espirometría se realizó de acuerdo con las normas de la Sociedad Torácica Americana (STA). Se seleccionó una muestra aleatoria multietapa de todo el país –formada por individuos no institucionalizados— para el reclutamiento con la ayuda del Instituto Estadístico de Jamaica (STATIN, en inglés). Todos los cuestionarios y datos de espirometría de los participantes consintientes fueron enviados electrónicamente al Centro Coordinador del Reino Unido para la depuración de datos, chequeo de calidad y análisis preliminar. Los datos finales fueron devueltos al equipo de investigación local para su posterior análisis.*

Resultado: *La muestra total seleccionada para el reclutamiento (y la tasa de respuesta) fue de 883 (91.4%) para las personas de ≥ 40 años y 190 (87.2%) para las personas de 70+ años. De los 164 encuestados en grupo de 70+ años, 91 (55.5%) tenían espirometría utilizable. La prevalencia de fumar ocasionalmente por edad y sexo en esta cohorte de 70+ fue de 38.4%. El trabajo en el campo (agricultura, cría de animales), la construcción y la limpieza doméstica fueron las ocupaciones más frecuentemente reportadas (58.8%). Los años de trabajo en estas tres ocupaciones oscilaron entre 1–70 (trabajo en el campo y construcción), y 1–78 (limpieza). La mayoría estaban ahora retirados (120 de 164 en total). La prevalencia ponderada estimada de la población de la Iniciativa Global para la Enfermedad Pulmonar Obstructiva Crónica (GOLD, en inglés) Etapa 1 (post-BD FEV1/FVC < 70%; FEV1 ≥ 80% valor teórico) fue de 12.1% en total para las personas de 40+, pero las*

más alta fue 37.8% en el grupo de 70⁺ años. La prevalencia estimada de GOLD Etapa 2 (50 ≤ FEV1 < 80% valor teórico) fue de 9.6% en los de 40⁺, y de nuevo 31.3% la más alta en el grupo de 70⁺ años de edad.

Conclusión: *La prevalencia general de la EPOC en el grupo de 40⁺ años, ya fuera en la etapa 1 (EPOC leve), o la etapa 2 (EPOC moderada), aunque pareciera baja, seguía siendo más alta en el grupo de 70⁺ años. Los datos locales revelaron que si bien la prevalencia de fumar regularmente había disminuido a la edad de 70⁺, la prevalencia estimada de EPOC en GOLD Etapa 1 y Etapa 2 fue mayor en este grupo etario. La contribución de las exposiciones ocupacionales al desarrollo de la EPOC requiere un análisis adicional para examinar las exposiciones ocupacionales en todos los participantes de 40⁺ años. así como la prevalencia de la EPOC entre los no fumadores. La progresión de la enfermedad de la etapa 1 a la etapa 2 y su efecto sobre la morbilidad y la calidad de vida es probable que tenga lugar si no hay educación del paciente con respecto a las complicaciones que el humo del tabaco y las exposiciones en el centro de trabajo tienen para el desarrollo de la EPOC.*

Palabras clave: Carga de enfermedad pulmonar obstructiva, enfermedad pulmonar obstructiva crónica, Jamaica, ocupación, tabaco

West Indian Med J 2018; 67 (5): 460

INTRODUCTION

Chronic obstructive pulmonary disease (COPD), is largely unknown in the Jamaican population and is often confused with asthma. It is a lung disease which presents mostly in the older population, with associated disability and comorbidities (1). Recent studies have demonstrated increased risk for cardiovascular disease among those with COPD (2). Tobacco smoking is widely acknowledged as the most important risk factor for COPD (1), however, occupational exposures and biomass exposures *ie* continued exposure to burning of coal or wood fires indoors, contribute to the disease prevalence. Industries associated with increased risk include the manufacturing of rubber, plastics and leather, building services, textile manufacturing and construction (3, 4).

Data on COPD in Jamaica is sparse. An older study reported that respiratory diseases accounted for 23% of deaths in a coroner's autopsy study of 841 sudden natural deaths between January 1983 and December 1997 (5). A more recent study on the economic burden of caring for tobacco-related illnesses, reported that approximately 42% of respondents with COPD spent more than half of their annual income to treat the disease (6).

The Burden of Obstructive Lung Disease (BOLD) is an international United Kingdom (UK)-based study seeking to establish the prevalence and burden of COPD worldwide (www.boldstudy.org). Jamaica, as a participating site, aimed to establish the prevalence of COPD in the Jamaican population.

SUBJECTS AND METHODS

Jamaica, as a participating site in the international UK-based BOLD study, obtained ethical approval to conduct the study from both the Ministry of Health (MOH) and The University of the West Indies (UWI) Ethics Committees. Approval of the sampling plan from the BOLD UK Coordinating Centre was obtained prior to launching the study. Each participant was also required to sign a consent form prior to participating in the study.

An island-wide, multi-stage sample of non-institutionalized individuals was drawn with the assistance of the Statistical Institute of Jamaica (STATIN). Eighty four primary sampling units (PSUs) island-wide were selected based on probability proportional to the size for each of the 14 parishes. Maps of each PSU were obtained from STATIN to facilitate identification of the eighteen dwellings to be sampled in each PSU whereby the first dwelling was randomly selected and successive dwelling units identified by a sampling interval (calculated as total number of dwellings within each PSU divided by 18) to ensure an adequate geographic spread throughout the PSU. All members of the selected dwellings aged ≥ 40 years were selected for recruitment for inclusion in the sample.

Following the BOLD protocol, upon obtaining individual consent, questionnaire administration to assess sociodemographic characteristics, smoking practices, respiratory symptoms and occupational exposures was

by face-to-face interviews (7). Pre- and post- bronchodilator spirometry in participants aged ≥ 40 years were performed according to the American Thoracic Society (ATS) standards with three acceptable and reproducible manoeuvres and no more than 200 mLs variability between manoeuvres (7). Spirometry was performed by trained and certified field workers using the nDD Easy One spirometer at all participating sites. Continuous monitoring of the spirometry technicians was maintained throughout the study to ensure quality control. All data were securely sent electronically to the UK Coordinating Centre. Spirometry curves were considered satisfactory only if they met ATS acceptability and reproducibility criteria. This was the first time spirometry was being used in the field to diagnose COPD in our local population. Participants identified for inclusion in the sample but who did not wish to participate in the full protocol were asked to complete a Minimal Data/ Refusal Questionnaire.

The Occupational Questionnaire enquired about time spent in thirteen occupations including coal – mining, sand blasting, working with asbestos, welding, farming, construction, foundry or steel milling, cleaning *eg* domestic and industrial cleaning, working with detergents, disinfectants, or other chemicals (7). Occupational exposures were categorized into Group 1 - organic dust (farming; flour-, feed- or grain-milling; cotton- or jute-processing); Group 2 - inorganic dust (working with asbestos; coal-mining; hard-rock mining; sandblasting; construction) and; Group 3 - irritant gases, fumes or vapours [welding; firefighting; chemical or plastic manufacturing; public transportation, dry-cleaning chemicals] (9).

A Spirometry questionnaire was administered to ascertain participant safety to perform spirometry testing. Pre and post-bronchodilator spirometry (after administration of 2 puffs of Salbutamol given by individual spacers) was performed by participants. To distinguish from asthma, irreversible airway obstruction was defined according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines as a post-bronchodilator $FEV_1/FVC < 0.7$ (1).

RESULT

Total sample selected for recruitment was 883 for persons aged 40^+ years overall and 190 for persons aged 70^+ years. Response rate (defined as all responders with or without acceptable spirometry as a proportion of the total selected for recruitment less those deemed untraceable) was 91.4% and 87.2%, respectively. Of the traceable sample in the 70^+ age group, 164 completed the standard BOLD Occupational Questionnaire of which 91 had usable pre- and post-bronchodilator spirometry following the ATS criteria (Table 1).

The results reported on herein are based on the 164 responders and, where applicable, the subset 91 with usable spirometry readings. Non-weighted proportions are presented except where reporting on the estimated population prevalence of GOLD Stages 1 and 2.

The sample comprised 95 females (57.9%) with ages ranging 70–95 years (median 76) and was predominantly rural. Current and former smokers accounted for 38.4% overall with a significantly highly proportion among males (63.8%) *versus* females (20.0%), (Pearson's Chi-Squared test statistic = 32.3646, $p < 0.001$). Weighted estimated population prevalence of GOLD Stage 1 (Post-BD $FEV_1/FVC < 70\%$; $FEV_1 \geq 80\%$ predicted) was 12.1% overall for persons aged 40^+, but was highest at 37.8% in the 70^+ age group. Estimated prevalence of GOLD Stage 2 ($50 \leq FEV_1 < 80\%$ predicted) was 9.6% in the 40^+, again highest at 31.3% in the 70^+ age group (results not shown).

Farming (Group 1), construction (Group 2) and cleaning (Group 3) were the most frequently reported occupations in this 70^+ group. Years reported in these occupations ranged from 1–70 years farming and construction and 1–78 years in cleaning (Table 2). A further 69 (or 42.1%) responders did not report any of the 13 occupations listed and, hence, were not included in Groups 1, 2 or 3 (Table 2, Figure).

DISCUSSION

The BOLD (JA) study was an island-wide study to establish the prevalence of COPD in Jamaica. The study was completed in June 2015 and all questionnaire and spirometry data were reviewed by the Coordinating Centre in the UK. Data were cleaned and returned to the local researchers in Excel files. All participating sites used the nDD spirometer for the spirometry exercise, and completed standardized core, occupational, cigarette smokers, spirometry, biomass and fuel, and tracking questionnaires (7).

In fulfilling the ATS criteria for acceptable useable spirometry, the study results reflect a low percentage prevalence of COPD. Most of the COPD prevalence was Stage 1 (mild) - 12.1% more so than Stage 2 (moderate) 9.6%. Spirometry is essential to the diagnosis of COPD. However, the study showed some difficulty producing quality reproducible, spirometry, with less than 200 mL variability from our participants. Spirometry was a

Table 1: Demographic ad clinical characteristics of responders in the burden of obstructive lung disease (Jamaica) Study aged 70 and older (n = 164)

	Males	Females	Total
Total selected for recruitment	80	110	190
- Responders with usable spirometry**	44	47	91
- Responders without usable spirometry**	25	48	73
- Refused to participate (but minimal data collected)	10	12	22
- Unreachable[1]	1	1	2
- Untraceable[2]	0	2	2
**Total Responders:	69	95	164
Age			
- Range	70–90	70–95	70–95
- Median (IQR)	76 (73–79)	76 (72–81)	76 (72–81)
Location (%):			
- Urban	26 (37.7%)	49 (51.6%)	75 (45.7%)
- Rural	43 (62.3%)	46 (48.4%)	89 (54.3%)
Smoking status			
- Current	10 (14.5%)	1 (1.1%)	11 (6.7%)
- Ex	34 (49.3%)	18 (18.9%)	52 (31.7%)
- Never	25 (36.2%)	76 (80.0%)	101 (61.6%)
Doctor diagnosed asthma, emphysema, CB or COPD	8 (11.6%)	10 (10.5%)	18 (11.0%)
Doctor diagnosed COPD	1 (1.5%)	1 (1.1%)	2 (1.2%)
Other co-morbid conditions[3]	31 (44.9%)	70 (73.7%)	101 (61.6%)
Gold Stage 1[4]	20 (45.5%)	14 (29.8%)	34 (37.4%)
Gold Stage 2[4]	16 (36.4%)	12 (25.6%)	28 (30.8%)

** Responders are those who completed post-BD spirometry (regardless of QC scores) and the core questionnaire. The remainder of the table is based on the 164 responders

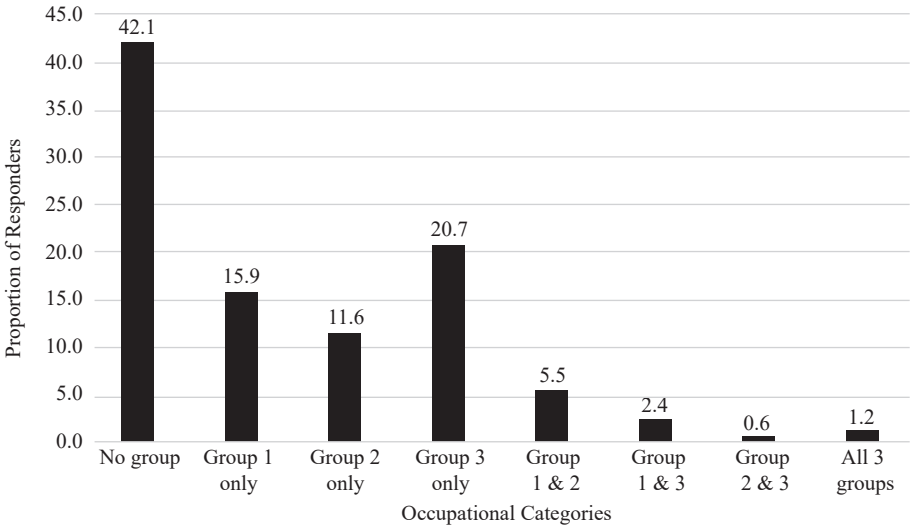
1. Contact information apparently correct, but no response to contact attempts
2. Contact information incorrect, no updated information available
3. Doctor ever diagnosed heart disease, hypertension, diabetes, lung cancer, stroke or tuberculosis
4. Non-weighted; based on the 91 respondents with usable spirometry

Table 2: Most frequently reported occupations, tobacco use and clinical characteristics among burden of obstructive lung disease (Jamaica) participants aged 70 and older (n = 164)

	Occupation			
	Farming[1]	Construction[2]	Cleaning[3]	Other[4]
No of persons	41	31	39	69
No of males (%)	31 (75.6%)	29 (93.5%)	2 (5.1%)	17 (24.6%)
Age*	70–90	70–90	70–95	70–90
	78 (73–82)	77 (74–79)	75 (72–82)	76 (72–81)
Years in occupation*	1–70	1–70	1–78	2–55
	30 (13–55)	30 (10–40)	10 (3–25)	20.5 (10–32)
Retired	25 (61.0%)	21 (67.7%)	35 (89.7%)	49 (71.0%)
No in rural location	29 (70.7%)	18 (58.1%)	16 (41.0%)	36 (52.2%)
Smoking				
- Current	5 (12.2%)	3 (9.7%)	2 (5.1%)	2 (2.9%)
- Ex	18 (43.9%)	17 (54.8%)	8 (20.5%)	16 (23.2%)
- Never	18 (43.9%)	11 (35.5%)	29 (74.4%)	51 (73.9%)
Doctor diagnosed asthma, emphysema, CB or COPD	5 (12.2%)	5 (16.1%)	8 (20.5%)	3 (4.3%)
Other co-morbid conditions[5]	19 (46.3%)	18 (58.1%)	28 (71.8%)	46 (66.7%)
Usable spirometry	25 (61.0%)	25 (80.7%)	20 (51.3%)	31 (44.9%)
Gold Stage 1[6]	11 (44.0%)	14 (56.0%)	7 (35.0%)	6 (19.3%)
Gold Stage 2[6]	8 (32.0%)	12 (48.0%)	6 (30.0%)	6 (19.3%)

* reported as [range; median (IQR)]

1. Farming was the only reported occupation categorized under “Group 1 – organic dust”
2. Construction categorized under “Group 2 – inorganic dust”. There was also one responder indicating hard-rock mining and two responders indicating working with asbestos
3. Cleaning categorized under “Group 3 – irritant gases, fumes or vapours”
4. No reported occupation categorized under Groups 1, 2 or 3 based on the 13 occupations included on the Occupational Questionnaire
5. Doctor ever diagnosed heart disease, hypertension, diabetes, lung cancer, stroke or tuberculosis
6. Non-weighted; based on the 91 respondents with usable spirometry



Group 1 – organic dust (includes farming), Group 2 - inorganic dust (includes construction) and Group 3 - irritants (includes cleaning).

Figure: Distribution of occupational categories among BOLD (JA) participants aged 70 and older (n = 164)

new test to the majority of participants and it required much concentration and effort to produce a satisfactory manoeuvre. Of the 164 responders in the 70^{+} age group, 73 (or 44.5%) of the spirometry readings were deemed unacceptable by the UK Coordinating Centre as they did not meet ATS standards.

The significant contribution of the 70^{+} age group to the overall prevalence of Stage 1 and Stage 2 COPD, calls into question not only smoking practices, but also occupational exposures in this age group. The recent literature published either on general population samples or on workplace samples, indicate that about 15% of all cases of COPD are work related (9). Among our 70^{+} study group the three common occupational exposures were farming and the exposure to organic dust, fumes from pesticides, construction – and exposure to inorganic dust. Cleaning – exposure to chemical irritants - coupled with the years of exposure, which was up to 78 years was a risk factor for development of COPD. Further assessment of the 70^{+} exposure data revealed that 69 (41%) of the respondents reported not working in any of the three exposure categories. However, 9.7% of respondents worked in a combination of two or three categories. Further analysis of the complete ≥ 40 years data is required to fully assess the impact of occupational exposure, with or without smoking exposure, on COPD prevalence locally.

This BOLD (JA) study was an island-wide study, using spirometry, a relatively unknown test to the Jamaican population to diagnose COPD. The challenges with spirometry were already highlighted. While the study boasts a good response rate, the sample was predominantly rural, particularly among the males. Urban participants identified from the mapping exercise were sometimes unwilling to participate, or had difficulty scheduling appointments for questionnaire administration and spirometry. The team was received warmly by the rural participants who were happy and willing to participate. More women than men were participants.

The results of the study show a low prevalence of current smoking in the 70^{+} population. The weighted estimated population prevalence of current smoking was highest in the 60–69-year age group and the airflow obstruction for Stage 1 or Stage 2 COPD was highest in the 70^{+} cohort (results not shown).

Despite a decline in current smoking by 70, the contribution of this age cohort to the overall prevalence of COPD was significant. Also, since 41% of the 70^{+} sample reported not working in any of the three occupational exposure categories, it would lead us to assume that the biggest contribution to the development of COPD by age 70 years in this cohort, was largely cigarette smoking. The impact of occupational exposure would require further examination of the data to look at the prevalence of COPD in non-smokers. One of this study's limitations was that participants captured were predominantly rural. Enough urban participants were not captured a factor which could undoubtedly influence smoking prevalence and by extension COPD prevalence. Despite its low prevalence, significant education is still required about

this to prevent this chronic lung disease. The impact of chronic tobacco use and occupational exposures on the development of COPD and its contribution to the burden of chronic non-communicable disease require more public education.

REFERENCES

1. Vestbo J, Hurd SS, Augusti AG, Jones PW, Vogelmeier C, Anzueto A et al. Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease: GOLD Executive Summary. Am J Respir Crit Care Med 2013; **187:** 347–65.
2. Bafadhel M, Russell REK. Are COPD and Cardiovascular Disease Fundamentally Intertwined? Eur Respir J 2016; **47:** 1307–1309.
3. Boschetto P, Quintavalle S, Miotto D, Lo Cascio N, Zeni E, Mapp C. Chronic Obstructive Pulmonary Disease and Occupational Exposures. J Occup Med Toxicol 2006; **1:** 11.
4. Blanc PD, Iribarren C, Trupin L, Earnest G, Katz PP, Balmes J et al. Occupational Exposures and the Risk of COPD: Dusty Trades Revisited. Thorax 2009; **64:** 6–12.
5. Escoffery CT, Shirley SE. Causes of Sudden Natural Death in Jamaica: A Medicolegal (Coroner's) Autopsy study from the University Hospital of the West Indies. Forensic Science. Forensic Sci Int 2002; **129:** 116–121.
6. Crawford TV, McGrowder DA, Barnett JD, McGaw BA, McKenzie IF, James LG. Tobacco-Related Chronic Illnesses: A Public Health Concern for Jamaica. Asian Pacific J Cancer Prev 2012; **13:** 4733–8.
7. Buist AS, Vollmer WM, Sullivan SD, Weiss KB, Lee TA, Menezes AM et al. The Burden of Obstructive Lung Disease Initiative (BOLD): Rationale and Design. COPD 2005; **2:** 277–83.
8. Buist AS, McBurnie MA, Vollmer WM, Gillespie S, Burney P Mannino DM et al. International variation in the Prevalence of COPD (The BOLD Study): A population – based prevalence study. Lancet 2007; **370:** 741–50.
9. Lamprecht B, McBurnie MA, Vollmer WM, Gudmundsson G, Welte T, Nizankowska-Mogilnicka E et al. COPD in Never Smokers: Results from the Population-Based Burden of Obstructive Lung Disease Study. CHEST 2011; **139:** 752–63.
10. Blanc PD, Menezes AMB, Plana E, Mannino DM, Hallal PC, Toren K et al. Occupational Exposures and COPD: an ecological analysis of international data: Eur Respir J 2009; **33:** 298–304.