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What will go wrong has gone wrong- Asbestos exposure risk among construction workers in Nigeria

--Manuscript Draft--

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Abstract:	Asbestos is a naturally occurring silicate with six varieties from two groups of minerals serpentine (chrysotile) and five amphiboles (amosite, crocidolite, tremolite, anthrophyllite and actinolite) with chrysotile widely used form. Asbestos containing materials (ACM) use in Nigeria from 1970 to 2000 was 1,091,370 tons. Its demand peak coincided with landmark edifices construction in the country that include FESTAC Village and the National Theatre Iganmu. The inward low cost housing construction investment policy in urban areas in the 1970-80s ensured demand for ACM was consistent. Given the widespread use of ACM and non-availability of national data on workers exposure, the problem posed is unlimited. Poor implementation of asbestos regulation and industry codes of practices contributed to inadequate risk management regime. Desktop survey on ACM demand revealed the product continual use, but goes unreported. Low cost of ACMs and the absence of strong regulation to enforce a ban in the industry are critical factors in their proliferation. Lack of official record for asbestos mortality or morbidity rates and the nonexistence of reliable mechanism to enforce its ban present serious health risk among construction workers. This call for national asbestos exposure survey to ascertain the extent of the problem within the construction industry.
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Response to Reviewers:	Paper changes based on reviewers comments received: 1.Abstract: Further improvement has been done. Asbestos types now included and potential scale of the problem in Nigeria emphasised 2.Introduction (Page 3 comments) a.Line 10: Clarity has now been provided and both sentences merged b.Line 47: Typo now amended c.Line 51: Insulation has now been added 3.Introduction (page 4 comments) a.Line 2: More clarity has now been provided to the earlier statement made taking on board the comments/suggested improvement b. Line 30: Grammatical error corrected 4.Introduction (page 5) a.Line 16: Distinction now made between varied form asbestos related effects b.Line 26: Discussion around asbestos fibre has been added c.Line 47: ILO stand on asbestos exposure added 5.Introduction (page 6) a.Line 5: Canadian chrysotile production and controversy of the process has been included 6.Asbestos use in Nigeria (page 7) a.Line 7: There is paucity of data on the subject in Nigeria. However, one study reporting misdiagnosis of Mesothelioma for tuberculosis has been added to support the gap b.Line 20: Estimate has now been provided 7.Asbestos use in Nigeria (page (page 8) a.Line 5: Evidence provided to support the claim b.Line 24: Typo amended c.Line 30: Typo amended 8.Asbestos exposure among construction worker in the country (Page 9)

	a.Line 22: Typo amended b.Line 43: Concern raised has now been addressed and estimate of potential burden strengthen c.Line 58: Projected asbestos related cancer cases has now been included 9.Asbestos exposure among construction worker in the country (page 10) a.Line 21: Grammar concern has now been improved 10.Asbestos exposure among construction worker in the country (page 11) a.Line 26: Earlier statement made has been improved based on the concern raised 11.Conclusion (page 14) a.Line 21: Conclusion now reduced under 400 words

Table

Table 1: Predicted 15 year cumulative mortality arising from mesothelioma (1994-2008) in African countries using asbestos but not reporting mesothelioma frequency

Country	Cumulative use of asbestos (tons), 1920–1970	Predicted cumulative mortality (n)	95% CI
Zimbabwe	122,595	447	323-617
Algeria	90,005	337	238-477
Swaziland	87,868	329	232-468
Morocco	55,697	217	147-321
Nigeria	34,443	140	91-216
Democratic Republic Of Congo	22,579	95	59-153
Uganda	18,139	78	47-128
Zambia	15,607	68	41-113
Mozambique	14,566	64	38-107
Angola	14,378	63	37-106
Tunisia	9,724	44	25-77
Kenya	3,153	16	8-31
Botswana	1,163	6	3-14
Senegal	799	5	2-10
Libya	540	3	1-7

Adapted from Park et al. 2011

Table 2: Common asbestos products and their use in typical buildings with asbestos in Nigeria

Product	**Use in building***
Roofing sheet (flat or corrugated)	Roofing, wall cladding and water gutters
Textured/stipple coated ceiling	Ceilings, facades, partitions
Asbestos-Cement Pipe	Delivery of portable water and drainage system
Window putty	Window and door glass sealant
Stucco	Coating of wall/ceiling surfaces and architectural decorations
Vinyl tiles, linoleum flooring sheet etc.	Flooring of indoor space
Flooring adhesives	Laminating floor materials
Toilet pipe lagging	Drainage work
Cement panel	Roofing panel

*Information in the table was compiled based on internet search around asbestos product sue in Nigeria.

Figure

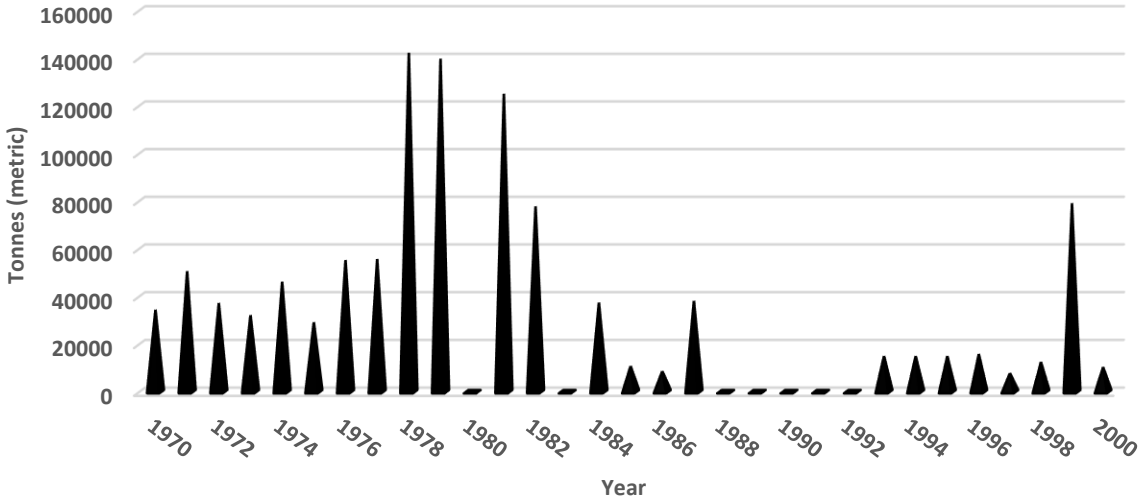

Figure 1: Nigeria annual global asbestos import (1970-2000) (source- British Geological Survey)

1. Introduction

The public health significance of asbestos cannot be understated. Originating from ancient Greek terminology, its derivation is “inextinguishable, unquenchable or inconsumable”. Asbestos has notorious characteristics as a fibrous, solid, chemically non-reactive carcinogen. It is a naturally occurring silicate with six varieties from two groups of minerals, namely the serpentine (chrysotile) and the five amphiboles (amosite, crocidolite, tremolite, anthrophyllite and actinolite). Because of its fibrous and crystalline characteristics, the product was successfully commercialised in the Industrial age, and extensively used in the 20th Century. Findings revealed that 95% of world asbestos production has been chrysotile (white asbestos) and is the most widely used form of asbestos (Kanarek, 2011, Ruff, 2017) and this paper focuses on the use and exposure of white asbestos (chrysotile) in Nigeria.

Historically, asbestos has been used in a diverse range of human activities, which include paintings, ceramic and pot making, lamp wicks, cigarette filters, brake pads and other ancient artefacts with evidence suggestive of ancient Egyptian use as clothing to preserve the bodies of dead pharaohs (Marioryad et al. 2011, Kratzke and Kraztke, 2018). In addition to its use, both ancient and contemporary, the issues around disposal, and its continued and often unregulated use mean it is environmentally ubiquitous (Virta, 2006, IARC, 2012). Its high tensile strength, flexibility, resistance to chemical and thermal degradation, high electrical resistance, low electrical conductivity, and large surface area characteristics make it a cost-effective and commercially viable building material. These qualities have informed the product high demand in construction industries globally in the 20th Century and continue to do so, especially in developing countries (Joshi and Gupta, 2004, Virta, 2006, Marioryad et al. 2011). In addition, its unique characteristics makes it a highly desirable material in several applications that include, car break liners, gaskets, insulation and packing materials in industrial and maritime settings, such as refineries, chemical plants, naval ships, and energy plants (Joshi and Gupta, 2004, Marioryad et al. 2011, Madl et al. 2014, WHO, 2015). However, its shape and size plays a crucial role in the incidence of asbestos exposure-related chronic diseases. The evidence for asbestos exposure-related chronic morbidity and high mortality has resulted in global awareness and campaigns to ban its use, with strict measures implemented in many nations aimed at reducing asbestos exposure. In high-income countries, this has led to a gradual decline in the number of new cases of cancers linked to environmental and occupational asbestos exposure. Conversely, currently undiagnosed cases from historical exposure are a concern, with recent reports in the UK postulating that despite rigorous control measures taken, the number of mesothelioma cases in the UK, especially among males would continue to rise, peaking in 2038, after which exposure related deaths would decline leaving only “background cases” (Tan and Warren, 2009). Background cases would result from historical exposure and the number of new cases of asbestos related exposure should in practice be eliminated. However, based upon current practice and regulatory frameworks in Nigeria, there is a high likelihood of a climbing incidence and prevalence of mesothelioma and other asbestos related conditions within the population.

An Asbestos ban in the European Union came into force on the 1st January 2005, in response to the persistent chronic asbestos-related disease. Projection of approximately 500,000 deaths caused by asbestos-related diseases are likely to be realised in Western Europe by 2030 (Vogel, 2005). In 2008, South Africa announced a ban on the use, manufacturing, import and export of asbestos and asbestos containing materials. Prior to the introduction of the ban, the country has a high case incidence of Asbestos related diseases during the year 1995 to 2007 with reported mortality of 2,509 total mesothelioma deaths (Franz, 2013). The lack of public health awareness campaigns by governments and other key stakeholders compounds a high likelihood of continued and more worryingly, increased exposure and subsequent diagnosis of chronic disease due to industrialisation and economic growth and expansion. This is a replication of high-income country experience throughout much of the last century (Lee et al. 2013, Hashim and Boffetta, 2014). The continued use of asbestos in developing has largely been encouraged by competing national developmental priorities, which now require urgent attention by nations where asbestos use is largely uncontrolled.

Since the 1900's, certain diseases have typically been associated with asbestos exposure (Boffetta, 2007, Bunderson-Schelvan et al. 2011). However, with the ban of the product in high-income countries in the late 20th Century this has resulted in marketing of the product to less developed, lower and middle-income countries, considered as having a weak regulatory approach toward the product ban implementation. As reported by Marsili et al. (2016) "suspicions that lung cancer may be associated with asbestos exposure were first reported in the USA and the UK in the 1930s, and decades later reports of pleural tumours associated with asbestos exposure followed". Several articles have reported on the association between asbestos fibre exposure to several forms of ill health that include pulmonary fibrosis, chronic obstructive pulmonary disease, pleural plaques, pleural effusion, pulmonary fibrosis (asbestosis), lung cancer, and mesothelioma of the pleura or peritoneum in humans (Harington and McGlashan, 1998, Joshi and Gupta, 2004, Braun and Kisting 2006, Tan and Warren, 2009, Bunderson-Schelvan et al. 2011, Lee et al. 2013, Hashim and Boffetta, 2014, WHO, 2014, WHO, 2015, Nynäs et al. 2016, Kratzke and Kratzke, 2018). Its exposure primarily occurs because of inhalation in the immediate environment and from ambient air near point sources. Exposure can occur in occupational settings either from dry cutting of asbestos containing products, repackaging of asbestos materials, exposure to physically damaged asbestos-containing products, clearing of debris, disposal and management of sites where asbestos is contained. Globally around 125 million individuals are estimated to be exposed to asbestos due to workplace exposure alone, with around 100, 000 yearly mortality from asbestos related disease (Joshi and Gupta, 2004; Braun and Kisting 2006, WHO, 2012, Lee et al. 2013, WHO, 2014). Given the regulatory environments in middle income countries (MIC) and low income countries (LIC), the absence of precautionary principle approaches and the lack of data on current mortality and morbidity, it can be reasonably argued that exposure cases and the resultant mortality goes unreported in these countries due to poor diagnosis, lack of knowledge and understanding and adhoc medical records management. Notably, Nigeria is not an exception and as a result of paucity of national data, It was not possible to

determine mortality incidence by asbestos types, however, it is on record that factories which were operational in Nigeria during the asbestos "boom" era were involved in the production of white asbestos materials (Eton, 2006, Sarauta and Bala 2014).

The International Agency for Research on Cancer (IARC) in 1973 categorised asbestos as a human carcinogen and 44 years later, WHO (2014) further confirms the relationship between exposure to either forms of asbestos -chrysotile, amosite and anthrophyllite or their mixture and the increased risk of lung cancer and mesothelioma among workers and those living around asbestos factories and mines, as well as among individuals living with asbestos workers. To date, countless studies into occupational and non-occupational exposure to asbestos have demonstrated strong links to asbestosis, mesothelioma and pulmonary disease and other diseases (Joshi and Gupta, 2004; Braun and Kisting 2006, WHO, 2012, Lee et al. 2013, WHO, 2014; Marsili et al. 2016). In considering the extensive epidemiological evidence of asbestos as a human carcinogen, over 50 countries have so far banned asbestos production and use, while several nations have applied strict restrictions on its use. Despite the widespread ban, there is still a market for mining, production, import and export of asbestos and associated products particularly in developing countries (Harington, and McGlashan, 1998, Takahashi and Kang, 2010). Lack of adequate measures to monitor the use of asbestos products by governments in these countries is seen as major shortfall that will lead to both the continuous exposure of workers to asbestos fibres and the extremely high risk to the health of these workers and their families. Considering this shortfall, International Labour Organisation (ILO) and WHO (2007), called for the adoption of a programme to eliminate asbestos related diseases among nations. This comprises the development of strategic policy within the national profile of health protection; awareness raising; capacity building; development of institutional frameworks and the adoption of a national plan of action for the elimination of asbestos-related diseases. Much is left to be seen in this area in Nigeria, due to the lack of adequate coordination of health improvement and disease prevention programmes, coupled with bureaucratic bottlenecks where major stakeholders tend to work in "silo" which hinders meaningful co-operation. Occupations that are at most at risk of asbestos fibre exposure and asbestos associated diseases range from construction work, the repairing, remodelling or demolition of buildings, service and maintenance work in buildings containing damaged asbestos-containing materials, and production of some auto parts, especially the making of brake and clutch pads (Erdinç et al. 2003). Where asbestos exposure remains, due to primary production or secondary use of its products, such as in South Africa, Zimbabwe, Nigeria, Brazil, Russian Federation and China, an estimated 1 million workers are said to be at high risk of developing mesothelioma (Joshi and Gupta, 2004, Braun and Kisting, 2006, Hashim and Boffetta, 2014, Marsili et al. 2016), thereby creating a high-risk "incubator" of asbestos related diseases (Lee et al. 2013). Thus, the burden of asbestos related disease in developing countries remains largely unknown (Boffetta, 2007, Bunderson-Schelvan et al. 2011). This is in part was compounded by the role played by developed countries in the marketing of these products up to the start of the 21st century. Canada until recently was a major producer and exporter of chrysotile asbestos where majority of the country's

production was exported to developing countries where little or no protection exists for workers or exposed populations. The Rotterdam Convention meeting held in Geneva 2011 saw Canadian delegation disapproval for the addition of chrysotile asbestos fibre to Convention to the surprise of other stakeholders. This was a further demonstration of the roles played by the country in the marketing of these products to developing countries at the detriment of the health of the workers and the public at large. While this was on going, the Canadian government were actively removing ACMs from all its public buildings and has placed ban on using the substance in any form. Despite these local efforts made at removing the product from circulation, the export trend continued due to the climate of silence evident from industrial partners within the country (Kirby, 2010, Kanarek, 2011, Frank and Joshi, 2014, Ruff, 2017).

Historical records indicate the global use of asbestos from 1920 to 2003 was around 180 million metric tons, with white asbestos (chrysotile) the commonest asbestos type utilised especially in the construction industry (Lee et al., 2013). Furthermore, Lin et al. (2007) estimates between 20–40% of global adult men might have held jobs that could have exposed them to asbestos dust. However, there are little or no records of asbestos exposure hazards documented in several developing countries including Nigeria. Despite the lack of epidemiological data in these countries, asbestos hazards and exposure, asbestos related disease and associated prognosis are issues that cannot be ignored because of the long latency periods following exposure that historically have masked the extent of occupational and paraoccupational illnesses associated with asbestos exposures. In most cases workers in these countries are more often than not engaged in asbestos risk reduction decision-making, and with high level of unemployment, it is very much easy to find willing individuals to take on any construction job irrespective of the hazard involved (Levy and Seplow, 1992). Generally, the nature of the construction industry in most developing countries, where it is not fully regulated is seen as a precursor to the “silence” on asbestos surveying in such countries. Addressing this illness prevention gap will contribute to the development of a comprehensive understanding of asbestos exposure and inform the development of strategies required to improve occupational safety, and minimise environmental exposure to optimise the health protection for all stakeholders.

2. Asbestos use-the Nigeria context

Up to this present moment, Nigeria have not introduced a ban on asbestos use and is also not listed on the International ban asbestos secretariat (IBAS) to have done so. Despite the lack of data on asbestos restrictions, there is no official record in Nigeria with respect to the occupational exposure of asbestos and subsequent development of asbestos related disease. This is now a matter of urgency as emphasised in this paper, and all stakeholders concerned should consider asbestos control and ban. The composition of asbestos types that has been used in Nigeria construction industry is unclear, however, in the 1970’s, Chrysotile was the most commonly used building material in Nigeria (Ogu and Ogbuozobe, 2011, WHO, 2014) because of its unique characteristics. Park et al. (2011) estimated the country’s cumulative use of asbestos (in tons) from 1920 to 1970 was 34,443 tons and a predicted cumulative

mortality of 140 with 95% CI 91-216 (Table 1). Its use in the country quickly increased after these years and data available from the British Geological Survey (BGS, 2017) showed Nigeria's global asbestos import volumes of 1,091,370 tonnes from 1970-2000 and peaked in 1978 with 142,242 tonnes imported into the country (figure1). Historically, asbestos-containing materials (ACM) has been used commercially in Nigeria as roof and wall claddings as well as decorative and acoustic applications, water and drainage pipes, electrical switchboards, insulators and fittings, vinyl floor coverings, asbestos felts and paper-like products. Other application include friction materials such brake linings, paints, coatings, sealants and adhesives, packings and gaskets (Ogu and Ogbuozobe, 2011, Idris et al. 2015, Yawas et al. 2016).

The peak of asbestos use in the nation construction industry was in 1970s which coincided with the construction of landmark edifices in Lagos State (the former capital city of Nigeria) such as the FESTAC Village with around 500 residential dwellings, the National Theatre Iganmu as well as other construction works around the entire country (Uzoma, 2013). In addition, the second republic government drive around the construction of low cost mass housing estates in every state of the federation saw a high consumption of the products in the country. Although little has been said of asbestos production in Nigeria, previous reports by Eton (2006) and Sarauta, and Bala (2014) revealed that up to 1996 asbestos cement and other products were manufactured locally as a joint ventures in remote settlements that include Bigi in Bauchi town. In addition, the UNDP (2006) report further contain evidence of asbestos production in other cities within Nigeria that include Kano, Lagos, Delta, Edo and Rivers. Evidence suggests the products are still in demand and use (Table 2) in the construction industry and in most cases, it goes unreported to relevant authorities (Vogel, 2005, UNDP, 2006). Further, during a two-day national stakeholders training workshop in 2015 organised by the Federal Ministry of Environment in collaboration with the World Bank, the United Nations representative called upon the country's government to ban the importation of asbestos into Nigeria (PM News, 2015), this statement is a further demonstration of the existence of ACM especially in the construction industry. The primary factor for the continuous use of asbestos products in the country is its low cost compared to other substitutes readily available and the absence of any strong regulation to enforce the ban of the product use within the industry. At present, the shift toward the use of alternative construction materials in the construction industry has done very little to eliminate asbestos use nor implement adequate risk management strategies around asbestos product use and asbestos containing materials already used in buildings.

Considering last decades has witnessed high demand and use of asbestos product in the nation's construction industry, what now becomes evident in almost every urban settlement is the production of large amount of ACM waste readily found among other wastes on construction sites and open field where most construction wastes are indiscriminately fly-tipped. This practice facilitates suspension of asbestos dust in the immediate environment thereby, constituting health hazard (Obiakor 1981, Ogu and Ogbuozobe 2011). The challenges posed by this scenario revealed the depth of challenges needed to control and reduce

occupational and para-occupational exposure of asbestos in the Nigeria. Several factors contribute to these challenges, which include lack of awareness of occupational hazards among workers and managers, low numbers of trained personnel, lack of or inadequate equipment and facilities to monitor exposure, inadequate infrastructure to identify and evaluate the risk, which informs sound policy development and preventive measures. To ensure success for any policy aimed at the prevention of asbestos exposures there is the need to encourage active participation of workers at each stage of the policy development and implementation. For this to work, site managers, supervisors, and trade union representatives will all have to take on roles to ensure effective social dialogue and participation (ILO, 2013). It is easy to suggest increased exposure risk among workers in the country is associated with the culture of lack of provision and use of respiratory protective equipment (RPE). Typical practices among workers on construction site is to use clothes worn from their homes as work attire. The implication of such practices is that with the lack of appropriate PPE usage on site, workers not only expose themselves to asbestos fibres and other pollutants but they can transport the materials home on clothing, hair and footwear, thereby contaminating their indoor environment and exposing their partners and children to asbestos fibre (Joshi and Gupta, 2004, Tanko and Anigbogu, 2012, Kolo, 2015).

3. Asbestos exposure among construction workers in the country

There is evidence pointing to early attempts made by the Nigeria government at looking into occupational asbestos exposure and possible health effects among construction workers as far back as 1976 (Okere, 1986) and in 1991, the World Health Organisation commissioned a study to undertake an inventory of ongoing research in Occupational Health and Environmental Epidemiology in Developing Countries (WHO, 1991, Levy and Seplow, 1992). Despite these past efforts, very little progress has been made on asbestos exposure survey and monitoring in Nigeria. In addition, there is no official record of mortality or morbidity rates caused by asbestos exposure within occupational and non-occupational settings in Nigeria. Park et al. (2011) calculated the predicted mortality cases for several countries that do not have data on mesothelioma frequency, of which 140 cases was predicated for Nigeria and ranked fifth in the continent based on 15-year cumulative mortality resulting from use of asbestos between, 1994-2008 (Table 1). There are grounds to conclude that actual mesothelioma cases in the country might be much higher, due to the high amount of the ACMs used in the past and poor pathologic diagnosis of presented cases. Other factors that might have contributed to the silence around mesothelioma and other exposure related cases in the country is attributed to the nonexistence of documented work exposures data among workers before the industry closure and the non-availability of environmental exposure record due to non-occupational reason. In 2015, the Nigeria Federal Ministry of Health implemented a national strategic action plan for the prevention and control of non-communicable diseases. The strategic action plan estimated 100,000 incident cases of cancers in general are reported annually in the country and with an estimation that the burden can increase fivefold if nothing is done by the 2020. A recently documented case evidenced poor diagnosis where a patient with malignant pleural mesothelioma was treated for pulmonary

tuberculosis (Oluwafemi et al., 2016) reflecting some of the challenges to addressing the problem. Based on this scenario around 1,000 or more from the incident cases reported by the Federal Ministry of Health might be associated with occupational asbestos exposure. Although there was no mention of annual mesothelioma mortality cases in the strategic plan, causal associations between high use of asbestos products in the construction industry and asbestos fibre exposure, related cancer cases and other forms of chronic respiratory diseases are likely. To improve working conditions and reduce exposure to asbestos fibre, investment in human capital through professional capacity building is ripe and will enable the implementation and monitoring of strategy aimed to reduce work related disease caused by asbestos fibre exposure.

A literature review and data search undertaken to determine training and awareness of asbestos handling in the Nigeria reveals a lack of such investment. There is need for a national survey to understand the state of training and awareness provision around management of asbestos to help ascertain the extent of human capital investment required in the construction industry. This is particularly relevant considering the lack of enforcement around the use of respiratory protection equipment (RPE) among construction workers while on site. In addition, the social and gender worker demographic in the industry revealed in some instances children accompany women to work on construction site, where in some cases these infants are carried on the backs of female workers while at work thereby exposing them to higher pollution rate (Tanko and Anigbogu, 2012, IARC, 2012, Kolo, 2015). Findings by Rosenstock et al. (2006) revealed that despite the geographical boundaries between developing countries, there are certain similarities that impact on occupational exposure to hazards such as asbestos fibre among the work force in these countries. The nature of the construction industry in the country means much activity occurs at micro level and the lack of compliance systems and associated workforce to monitor the industry, through enforcement, consultancy and general duty of care and corporate responsibility means the use of asbestos-based materials have gone uninspected for too long. To expand on this, at present in Nigeria, there is lack of clarity around which government agency is responsible for the implementation of the country's National Environmental (Construction) Regulation 2011 Section 14; use of asbestos considering that several departments are players but are viewed as operating in a "silo" fashion, which inhibit flow of information between each government department. In furtherance, the lack of published data on asbestos exposure awareness and training among construction workers in Nigeria emphasises the likelihood that workers on construction site will not be able to reliably identify building materials containing asbestos thereby further exposing themselves to inhalation dangers. In this case, any hazard and risk management prepared for the site might not be adequate to safeguard individuals from risk of exposure to asbestos fibres. This further highlights the need for pro-active measures aimed at increasing compliance and enforcement of existing health and safety regulations to reduce the risks associated with asbestos exposure. A policy of establishing data collection systems need to be introduced through local and regional agency bodies, from which an effective prevention strategy can be designed and implemented. This would require strategic efforts

to aid the development of appropriate channels capable of gathering exposure data from construction workers and medical practitioner reports. By encouraging regular environmental and health surveillance among workers within the industry, this will help identify vulnerable groups especially those with a long history of work in the industry and provide a good platform where workers can report misdiagnosed or new cases of asbestos related disease resulting from occupational exposure.

The federal government through its agency, the National Environmental Standards Regulatory and Enforcement Agency (NESREA) has the responsibility of enforcing environmental laws, guidelines, policies, standards that include use of asbestos in any construction work type (NESREA, 2017). However, the extent to which the task has gained momentum among the stakeholders is difficult to ascertain due to non-availability of information released by the agency to the public. With the lack of clear regulatory regime for asbestos handling in the country, it is imperative that good practices around exposure survey should be considered from successful practices elsewhere where there are functional regulatory frameworks. For example, the UK Health and Safety Executive has relevant information that if considered could assist in the risk assessment and management of asbestos exposure in Nigeria.

4. Assessment of Asbestos regulatory framework in Nigeria

While new construction use of asbestos products in Nigeria is in decline, the dangers of exposure to existing asbestos cannot be overstated. The decline in use is partly due to innovation in architectural design and the ban from asbestos mining and production in South Africa where most of the asbestos products are shipped and distributed around the African continent, including Nigeria (Braun and Kisting, 2006, Frank and Joshi, 2014). Despite this decline, there is little evidence of sound policy or strategy around the management and exposure prevention in old building stocks within the country. Considering that buildings containing asbestos products at regular intervals are either renovated or demolished in the country to make way for new structures, the lack of adequate decontamination protocols in the process will contribute to the disease burden. Fibres are very likely to escape into the immediate environment thereby increasing workers risk of exposure and at the same time, presenting higher chance of environmental exposure especially to residence living close to the construction site.

Because of the long latency period of between 15-60 years from the first asbestos exposure to the disease onset, the need to prevent exposure is paramount in order to reduce future cases of asbestos-related disease in the Nigeria. As part of the strategy, the National Environmental (Construction sector) Regulation 2011 section 14 (1) (2) prohibits the use of asbestos at any construction sites. In addition, the regulation has placed the responsibility on the operator to ensure every asbestos-containing material (ACM) is removed from the structure prior to demolition or any form of renovation that is capable of releasing the fibre into atmosphere. However, the regulation is silent around the management of asbestos in non-domestic buildings, where renovation or demolition occurs especially when property owners are renting the property to new clients or the building is converted for non-residential

use. Considering the unique nature of domestic construction work in the country, where local tradesmen who are less likely to have training and awareness around asbestos exposure mostly handle such projects, the regulation has not provided clear guidance on how removal of ACMs will monitored.

The Nigeria Building Code (2006) section 7.49.1 emphasises the need to consider workers health at every step of construction work undertaken:

> "Whenever a building or structure is erected, altered, repaired, removed or demolished, the operation shall be conducted in a safe manner and suitable protection for the general public and workers employed thereon shall be provided"

While this can be viewed as a significant health protection measure, the Building code lacks explicit emphasis around refurbishment or demolition surveys to identify the presence of asbestos containing materials, and it is this gap in worker risk assessment, which has not taken into consideration worker health, safety and wellbeing. While legally it is the responsibility of non-domestic property owner to manage asbestos in their premises, the case of Nigeria is unique due to the absence of strict regulations put in place to enforce the control measure. In addition, the Section 7.60.1 of Nigeria Building Code also gives special attention around hazardous material, which could pose a danger to the health of the worker:

> "Every construction or maintenance operation which results in the diffusion of…, dust, stone and other small particles, toxic gases or other harmful substances in quantities hazardous to health shall be safeguarded by means of local ventilation or other protective devices to ensure the safety of the workers and the public as required…"

The need to conduct effective risk assessment and evaluate the nature of the remediation work to be carried out is imperative to demonstrate adequate provision made to protect workers health involved in either demolition, maintenance, repair or refurbishment of building suspected as having asbestos containing materials (WHO, 2012, Lee et al. 2013). To add to this, the need for caution was earlier made in the 1986 Asbestos Convention, 1986 (No.162) as contain in Article 10 that;

> "Where necessary to protect the health of workers and technically practicable, national laws or regulations shall provide for one or more of the following measures (a) replacement of asbestos or of certain types of asbestos or products containing asbestos by other materials or products or the use of alternative technology, scientifically evaluated by the competent authority as harmless or less harmful, whenever this is possible; (b) total or partial prohibition of the use of asbestos or of certain types of asbestos or products containing asbestos in certain work processes".

To be able to apply asbestos convention standards in Nigeria context, there is an urgent need to harmonise political will, operational and information tools that can bring asbestos risk management within the country to the fore (WHO, 2007). In addition, it is not too late for the relevant Nigerian authorities to consider developing a central register for health surveillance of individuals previously exposed to asbestos fibre. If done, the move will help improve early diagnosis and treatment as well as development of adequate social and medical rehabilitation scheme.

Drawing on lessons of asbestos legacy in many countries, and the issues highlighted in this discussion paper, the significance of chronic asbestos related disease remains a major public health concern in Nigeria. To the best of our knowledge, there is minimal research around asbestos exposure and asbestos related disease in the Nigeria construction industry and our paper's aim is to stimulate discussion among professionals to facilitate dialogue and debate that will lead to adoption of policy designed to reverse the menace caused by occupational exposure to asbestos. Although, the National Environmental (Construction sector) Regulation in Nigeria has set out legal duties on the control and management of asbestos, there is no specific guidance in place that provides practical advice on how to comply with those requirements and ensure standards are applied consistently to protect employees from risks related to exposure to asbestos.

6. Conclusion

With undocumented anecdotal data, suggesting asbestos containing materials (ACM) are still in use in construction, and given the lack of asbestos survey practice and data collection in Nigeria, strategic investment in assessment and compliance systems are needed to control and minimise the risks to the general health of construction workers, and to protect public health more broadly. Hence, the relevant government body responsible for monitoring of ACM ban should consider a hazard and effect management process (HEMP) in their overall health safety management system as a means to address asbestos exposure risk among construction workers. Such a system will assist in the identification of individuals that might be exposed, and assist in the implementation of controls to prevent further exposure. Furthermore, the process will allow the development of a robust system of control measures as a means of eliminating or reducing the hazard while identifying the critical control measure and activities needed to maintain any developed control measure.

Based on paucity of Nigerian data on this issue, the authors are of the view that this paper is timely and will help stimulate conversation on the subject among different stakeholders within the country. Furthermore, due to the lack of information on the subject, it is almost impossible to estimate the number of individuals at risk of exposure to asbestos fibre in Nigeria. With an increase in general cancer cases, including lung cancer reported by the Federal Ministry of Health Strategic Plan, the historical evidence of asbestos use in the Nigerian construction industry, and with the long latency period of asbestos related disease, there are indicators on ground for unaccounted asbestos related disease within the country that is higher than any assumed figure. Since there is no safe exposure limit to asbestos fibre, a national asbestos exposure survey is needed to ascertain the extent of the problem within the construction industry.

To improve workers safety in the construction industry, personal respiratory equipment (RPE) compatible with other PPE should be encouraged as well as the need to have in place a robust system in place to monitor the management and handling of asbestos product within the nation's construction industry. To conclude, the lack of information on asbestos exposure

within the construction industry in Nigeria calls for urgent need to encourage research in this area.

Conflict of Interest

There is no potential conflict of interest related to this article

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5th May 2018

Dear Editor-in- Chief
Patrick Waterson

Cover Letter:

Enclosed is a revised manuscript titled "**What will go wrong has gone wrong- Risk of asbestos exposure among construction workers in Nigeria**" with all reviewers comments now addressed. This manuscript is not being considered for publication elsewhere.

The theme of the paper aim was to raise the safety awareness and arouse stakeholders thinking on how best to manage occupational asbestos exposure especially in developing countries. Key findings point to the fact that due to lack of cooperation from all stakeholders there exist a big black hole around the subject and is viewed as setback toward finding lasting remedy to what has already gone wrong.

Many thanks for considering my contribution for publication with the journal

Yours sincerely

Haruna M. Moda