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COMMENT

REGARDING: Public Comment on Regulations Relating to Minimum Uniform Norms and Standards for Public School Infrastructure

The following are comments on the Department of Basic Education's Draft Regulations Relating to Minimum Uniform Norms and Standards for Public School Infrastructure, which Minister Motshekga published for public comment on 8 January 2013. The Desmond Tutu HIV Centre provides these comments.

The Desmond Tutu HIV Centre ("The DTHC") is part of the Department of Medicine at the University of Cape Town and aims to impact policy and practice both nationally and internationally through relevant research, peer-reviewed publications, and feedback to government, civil society, and the community at large.

I. Abstract

Learners are required to attend school through the age of compulsory schooling and the state has a constitutional duty to ensure that learners are able to realise their right to a basic education. Learners are therefore compelled to spend time in public schools which

the state must reasonably act to ensure are safe and healthy environments. It is imperative that norms and standards for school infrastructure address issues of ventilation and overcrowding in classrooms and educational spaces in order to protect the health of learners and teachers while they are in public schools.

This comment focuses on the need to enact norms and standards regulations for proper ventilation in classrooms and other educational spaces and to prevent overcrowding in classrooms and educational spaces in order to control the potential spread of tuberculosis ("TB") and other airborne diseases in schools. South Africa is home to one of the largest TB epidemics in the world, with nearly 80% of the population carrying the disease. Young people are particularly vulnerable to infection.

In this comment we review the scientific knowledge relevant to TB transmission in schools; outline the ways that schools are sites of elevated risk for TB exposure and transmission; present data from a study being conducted by the Desmond Tutu HIV Centre demonstrating the fact that schools are currently locations of elevated risk of TB exposure and make recommendations relating to infrastructure that can minimise risk of TB exposure and transmission in schools.

II. Introduction

South Africa is home to one of the largest TB epidemics in the world. It is estimated that nearly 80% of the population is carrying the disease (NSP). Moreover, young people are particularly vulnerable to infection (NSP).

South African law requires learners aged 7 – 15 to attend school [SASA Section 3], therefore this vulnerable population is compelled to spend time in schools governed by the state. Moreover, learners who are older than the age of compulsory schooling possess a constitutional right to a basic education, which the state respects and promotes by providing learners with access to public schools. As explained later, it is imperative that the Department of Basic Education address issues of ventilation and overcrowding in classrooms and educational spaces in order to protect the health of learners and teachers while they are in public schools.

The January 8th, 2013 Norms and Standards for School Infrastructure published by Minister Motshekga in the Government Gazette ("Norms and Standards") inadequately address critical aspects of school infrastructure[1] that impact learner health and wellbeing.

1 "School infrastructure is broadly conceived to include the physical teaching and learning spaces (classrooms, laboratories, computer laboratories; workshops and other specialized teaching rooms); spaces that support teaching and learning (media rooms, multi-purpose resource centers, multi-purpose school halls, gymnasia, libraries, counseling centers, health centers); sport facilities; school administrative facilities; facilities for school nutrition and feeding programs, and teacher housing etc." (NPEPA, 1.6)

The norms and standards must take into consideration aspects of infrastructure that impact the health and wellbeing of learners and teachers. This comment focuses on the need to enact norms and standards regulations for proper ventilation in classrooms and other educational spaces and for preventing overcrowding in classrooms and educational spaces in order to prevent the spread of tuberculosis ("TB") in schools.

III. Health Imperative

IIIa. What is tuberculosis?

Tuberculosis ("TB") is an infectious bacterial disease caused by the bacterium *Mycobacterium tuberculosis*. TB is spread from person to person through the air when individuals with active TB infection of the lungs cough, sneeze, or talk. Individuals nearby may breathe in the bacteria expelled by an infected individual and become infected themselves. TB typically attacks the lungs but it can also infect other parts of the body such as the kidneys. Most people infected with TB have latent TB, which means they have no symptoms, but about 10% of latent infections will progress to active TB disease, which can be lethal without proper treatment. TB, even in non-fatal cases, significantly impacts the learners' ability to achieve in school because it leads to high rates of absenteeism amongst infected learners and impacts ill learners' ability to focus in the classroom.

IIIb. Why is tuberculosis an issue in South Africa's schools?

South Africa has the third highest burden of TB in the world (WHO), with roughly 400,000 new cases of TB in 2010 and an incidence that has increased by 400% in the last 15 years (NSP). Government estimates that 80% of the population is infected with TB, however not all of these individuals will develop active TB disease (NSP).

TB infections are predominantly acquired indoors, including in schools (Roberts et al 2012). Schools are one of the top locations where people spend time indoors (Wood et al 2012). The possibility of TB transmission is determined by the number and duration of social contacts made in locations that are conducive to TB transmission (Wood et al 2012). 97.2% of indoor time and 80.4% of total indoor contacts occur in schools, homes and transport (Wood et al 2012). Learners spend the second most amount of time indoors in schools, after their homes, making schools a significant environment where they are exposed to airborne pollutants including TB bacteria (Simoni et al 2012).

Schools are a high-risk location for TB transmission, especially amongst older learners (ages 15-19) and are therefore important locations for TB infection and thus TB prevention efforts (Wood et al 2012). By the time children enter school at age 5, 20 percent are already infected with TB (Wood 2010). By the time they reach the age of sexual maturity, 13 years, 50 percent are infected (Wood 2010). And between the ages of 24 and 28 -- the years of peak prevalence of HIV -- 80 percent are infected (Wood 2010). As people age from 15 to 21 their capacity for transmitting TB disease increases (Wood et al 2012). Thus when older learners attend classes this adds to the possibility for transmission of TB within the classroom, further heightening the need for ventilation and safe air quality in classrooms.

Children are more vulnerable to indoor air pollutants including TB particles than adults are, because children breathe more relative to their body weight and their bodies are less able to cope with toxins (Faustman et al 2000; Suk et al 2003). Therefore, ensuring adequate indoor air quality of schools is a priority to maintain the health and wellbeing of learners.

IIIc. What can be done to reduce TB transmission in schools?

One effective mechanism for reducing TB transmission is rapid identification, isolation, and treatment of individuals with TB. However, in school settings this is not feasible due to lack of properly trained health workers in schools in under-resourced areas in particular. Proper healthcare screenings that would allow for identification of active TB cases are not always available for learners and teachers who come and go from the school premises each day and would therefore need to be constantly screened in order to identify learners and teachers before they are able to infect others. Furthermore, isolating learners suspected of carrying TB but who are not properly diagnosed by a trained health care professional is a discriminatory practice that could result in a learner wrongly being denied access to education.

The best practicable mechanism to reduce the likelihood of TB transmission in schools is therefore to enact regulations ensuring safe indoor air. Essential components of ensuring safe indoor air quality are 1) providing adequate ventilation with outdoor air such as by allowing outside air to dilute indoor air, 2) filtering indoor pollutants, including bacteria particles, and allowing these pollutants and other contaminants to be exhausted from the building, and 3) reducing rates of re-breathed air by preventing overcrowding in classrooms.

Engineering appropriate infrastructure, including air filtration and proper ventilation, increases the room ventilation rate and thereby increases the removal rate of harmful TB bacteria from rooms (Fennelly and Nardell 1998). Such engineered infrastructure is superior to other mechanisms of removing harmful TB bacteria, for example personal respiratory protection, because it protects all individuals in the educational rooms and it does not depend on human behavior to be effective (Fennelly and Nardell 1998). Air filtration and proper ventilation is ideal for use in areas where there may be exposures to unsuspected TB patients, such as educational spaces (Fennelly and Nardell 1998).

Preventing overcrowding is important to limit the amount of re-breathed air, which may be contaminated. Preventing overcrowding is also important for ventilation systems to be most effective.

Historically, such modifications to the environment have been effective in reducing TB rates in highly impacted populations (Schmidt 2008) as will be described below in

Section IVd.

IV. Scientific Evidence Supporting These Recommendations

IVa. The relationship of classroom ventilation to health outcomes

The fact that ventilation rates are associated with health outcomes is biologically plausible (Sundell et al 2011). Ventilation rates impact the amount of re-breathed air in a room. Breathed air impacts the brain by means of blood oxygenation (Bako-Biro et al 2012). Scientific research demonstrates that lower ventilation rates aggravate health problems and increase symptoms such as inflammation, respiratory infections, asthma symptoms and short-term sick leave (Sundell et al 2011). Higher ventilation rates are associated with fewer symptoms (Sundell et al 2011) and reduce the prevalence of airborne infectious diseases (Seppanen and Fisk 2004).

Poor indoor air quality in schools is related to certain health problems and symptoms in learners (Daisey et al 2003; Fraga et al 2008; Mi et al 2006) especially asthma and rhinitis in children (Annesi-Maesano et al 2012) and increased respiratory disturbances in learners (Simoni et al 2010). Children with allergies and underlying health problems are at greater risk for negative health effects of poor air quality in schools (Annesi-Maesano et al 2012). Given the fact that allergies and other health problems are common in children, and that school attendance is mandatory, the public health impact of poor indoor air quality in schools is profound. Inadequate ventilation results in greater concentrations of indoor air pollutants such as allergens, fungi and bacteria that may cause health symptoms in learners exposed to them (Daisey et al 2003). Researchers recommend that ensuring adequate ventilation in classrooms and educational spaces be a major focus of design efforts (Daisey et al 2003).

Ventilation with outdoor air plays a critical role in human exposure to indoor pollutants (Sundell et al 2011). Increasing ventilation rates results in decrease of negative health symptoms (Sundell et al 2011). Therefore norms and standards for school infrastructure must ensure that classrooms, libraries, and other educational spaces as defined by NPEPA 1.6 where learning takes places and where learners are required to spend time, are properly ventilated and that classrooms are not overcrowded.

Specific strategies to include proper ventilation may include size and location and amount of window openings on either side of the room to allow for cross flow of air, allowing teachers to unlock and open windows when necessary to achieve ventilation, airing out rooms between classes, providing classrooms with devices to monitor CO_2 levels in rooms [measuring CO_2 levels indicate level of re-breathed air], creating daily window-opening schedules in schools, providing ventilation systems, allowing fresh air into rooms at regular intervals, and using fans to ventilate (BRE 2006; Greenberg 1929; Janssen 1989; Simpson 1924).

IVb. The relationship of room ventilation to the spread of TB

Household studies conducted in South Africa demonstrate that increasing room ventilation can reduce TB transmission, especially when increased ventilation is combined with limiting contact with infected individuals (Wood et al 2010). Canadian researchers Menzies et al. (2000) documented "a strong inverse association between an air change rate below 2 h^{-1} and tuberculosis infection among hospital workers in general patient areas" (Menzies et al 2000). The cross-sectional Health Effects of School Environment Study conducted in Europe found that children from poorly ventilated classrooms had a higher prevalence of respiratory disturbances such as dry cough and rhinitis (Simoni et al 2010). Overall, inflammation, communicable respiratory infections, asthma, and short-term sick leave all increase with lower ventilation rates in buildings (Sundell et al 2011).

This research helps draw a clear connection between ventilation rates and health of individuals, particularly students and this work demonstrates that ventilation rates are relevant to the spread of communicable respiratory infections including TB.

IVc. The relationship of classroom ventilation to learner performance

Apart from risk of disease transmission, poor air quality makes it difficult for learners to stay alert and focused in the classroom. Research demonstrates that poor classroom ventilation has been linked to learner absenteeism (Shendell et al 2004), decreased learner performance (Bako-Biro et al 2012; Coley and Greeves 2004; Haverinen et al 2011; Mendell and Heath 2005; Smedje et al 1996; Wargocki et al 2007), specifically through reduced learner attention and vigilance (Bako-Biro et al 2012) and has been shown to have a negative impact on learner concentration and ability to remember lessons (Bako-Biro et al 2012). These negative effects are even greater when learners must conduct complex tasks (Bako-Biro et al 2012). Extensive research conducted in primary schools in the United Kingdom demonstrate that improving ventilation in classrooms significantly improved learner performance on educational tests such as word recognition including learners responding faster and more accurately to tasks (Bako-Biro et al 2012).

IVd. Natural versus mechanical ventilation

A government issued study of schools in the United Kingdom details the impact that basic procedures, such as opening windows and internal doors, can have in the regulation of carbon dioxide, thereby demonstrating that proper ventilation is essential to avoid exceeding the maximum levels of carbon dioxide and protecting students from health risks. This report finds that naturally ventilated schools can achieve the suggested performance standards yet intervention and control are required (BRE 2006).

Early studies done in the United States suggested that naturally ventilated schools, for example schools that used open windows for ventilation, have fewer absences related to respiratory illness than schools that were only mechanically ventilated (Greenburg 1929; Janssen 1989; Simpson 1924). An example of mechanical ventilation is the use of fans.

Simpson (1924) made the statement: "fan-ventilated rooms showed 18 per cent more absences due to respiratory illness and 70 per cent more respiratory illness among children in attendance, in spite of the fact that *per capita* floor space was greater in these than in the window-ventilated rooms," (Simpson 1924:169). Simpson therefore recommended that air must move during weekends, evenings, etc. rather than remaining stagnant when the school is unoccupied in addition to installing fans in classrooms. This recommendation, though from 1924, still holds true today and persuasively demonstrates the importance of natural ventilation to reduce respiratory illnesses.

At the time Simpson made this recommendation, over 80% of the American population was becoming infected with TB before the age of 20, and TB was the leading cause of death in the United States. Because antibiotics or other treatments were not available at that time, TB control policies relied solely on measures such as ventilation to limit exposure to infected individuals. These preventive measures are still critical aspects of TB prevention and control programs today and are particularly relevant to South Africa because of the widespread TB epidemic we face in this country.

The energy referenced on page 7 of the draft regulations for Norms and Standards released in January 2011, stating that "a school should be provided with some form of energy which complies with all relevant laws," should therefore be amended to require energy which is, at the very least, adequate to operate fans in classrooms.

IVe. The negative impact of overcrowding

Overcrowding in classrooms and educational spaces increases TB transmission risk (Baker et al 2008; Johnstone-Robertson et al 2011; Schmidt 2008; WHO 2009). Extremely overcrowded classrooms pose a safety threat to learners (NPEPA 4.10.1). It is therefore imperative that regulations include measures to prevent overcrowding in classrooms and educational spaces (Prill 2000). Overcrowding can result in unhealthy air because it increases the quantity of rebreathed air. When the number of individuals in a room exceeds the capacity of that room, then air circulation is curtailed and learners are forced to breathe in a higher volume of rebreathed air as opposed to fresh air, which thereby increases the chances of inhaling infectious agents such as TB particles. Furthermore, in overcrowded classrooms ventilation systems are unable to be effective.

V. Norms and standards must be consistent with other national guidelines and regulations

Va. Norms and Standards must be consistent with the National Strategic Plan for HIV, STI and TB Control 2012-2016.

In 2011 the government enacted its National Strategic Plan for HIV, STI and TB Control for 2012 – 2016. Among other things, the strategic plan emphasises the need for norms and standards to address ventilation and overcrowding in public schools in order to reduce the high rate of TB infection and transmission, which currently persists throughout South Africa. Specifically, the document highlights that children and people who live and work in poorly ventilated and overcrowded environments are considered key populations for TB and that minimum standards must be developed for schools that take airborne infection control into account.

The minister of health considers children to be one of the key populations targeted for TB control (NSP). Children are amongst those who are particularly vulnerable to progressing from TB infection to TB disease. Other such vulnerable groups include people living with HIV, diabetics, smokers, alcohol and substance users, people who are malnourished, migrant and refugee populations and people living and working in poorly ventilated environments (NSP:27).

The Minister of Health argues that respiratory infection control should be prioritised in schools (including preschool facilities) in addition to prisons, high-risk industries such as mines, single-sex hostels, long-distance public transport (such as taxis, buses and trains), homeless shelters and repatriation centres (NSP). Furthermore, the National Strategic Plan on HIV, STIs and TB 2012 – 2016 states that:

> Infection control should be considered to be a component of health impact assessment for all new government and private-sector projects and programmes, in particular in developing minimum standards for buildings that take into consideration airborne infection control. Annual risk assessments should be carried out and 90% of high-risk institutions (schools, health facilities, prisons and mines) should achieve a basic infection control standard (NSP: 44).

Va. Norms and Standards must be consistent with the South African Constitution.

Very recently, in the case *Dudley Lee v. Minister for Correctional Services* Case CCT 20/12 [2012] ZACC 30, concerning the case of Mr. Lee who alleged to have contracted TB while in prison, the Constitutional Court found that responsible government authorities have a duty to take reasonable measures to protect vulnerable populations from communicable diseases while they are accommodated in institutions under the state's care. The Constitutional Court in *Dudley Lee* held that the prison authorities violated Mr. Lee's constitutional rights by failing to institute reliable measures to prevent the spread of tuberculosis (para. 8). Learners in schools are a similarly vulnerable population. Taking reasonable measures to protect this population of learners from communicable diseases entails creating minimum norms and standards that would require adequate ventilation and prevent overcrowding in classrooms.

Although learners have increased freedom of movement when compared to prisoners, they are similarly a vulnerable population. Firstly, their youth makes them inherently a vulnerable population. Secondly, education is mandatory; children must spend significant time in their assigned classrooms. If the conditions of these classrooms increase the spread of disease, children do not have any recourse. Learners are a vulnerable population and the responsible authorities have a duty to take reasonable measures to prevent the spread of TB in schools.

The Court in *Dudley Lee* declared, "TB is an airborne communicable disease which spreads easily especially in confined, poorly ventilated and overcrowded environments" (para. 8). The court readily acknowledges these conditions as conducive to the spread of TB. Many classrooms across South Africa are poorly ventilated and overcrowded. These environments expose learners to greater risks of exposure to TB. In order to address these issues, the underlying conditions must be addressed. Schools should therefore be required to have adequate ventilation and a reasonable amount of learners per classroom.

Learners have the same rights as Mr. Lee to the common law notion of respect for and protection of physical integrity, and under the Bill of Rights to human dignity (section 10; 30) and life (section 11; 31) (para. 13). Negligent omissions to provide for the physical integrity and well-being of learners violates their right to dignity and potentially their right to life. In *Minister of Safety and Security v. Van Duivenboden* [2002] 3 All SA 741 (SCA) (22 August 2002**)**, the Constitutional Court held, when "the constitutionally protected rights to human dignity, to life, and to security of the person, are all placed in peril and the state, represented by its officials, has a constitutional duty to protect them." (para. 22). School officials are under a constitutional duty to protect the rights of learners to human dignity, life, and security. In addition, *Dudley Lee* implicated "democratic values of state accountability, responsiveness and the rule of law" (para. 69) and these values likewise dictate that learners should have their rights respected. Moreover, the South African Constitution states, "A child's best interests are of paramount importance in every matter concerning the child" (s. 28) and it is self-evident that it is in the best interest of children to have access to safe school environments. Minimum norms and standards that fail to effectively address classroom overcrowding and ventilation standards increase the likelihood that learners will contract tuberculosis in schools and thus violates the state's duty to protect this vulnerable population of learners.

The reasonable measures that a prison can take to prevent the spread of TB differ greatly from the options schools have, yet education officials still have the same responsibility to protect their learners. Prisons are insulated and screening, isolation, and medication may be appropriate ways to reduce the risk of contagion. In contrast, learners leave their schools every day and screening is not feasible as outside circumstances cannot be controlled and schools simply do not have the capacity to screen learners on a daily basis. In addition, isolating learners is a discriminatory approach that would violate their rights. Thus, schools have to pursue alternative options. Reasonable measures for schools to take include ensuring that classrooms are properly ventilated and reducing overcrowding.

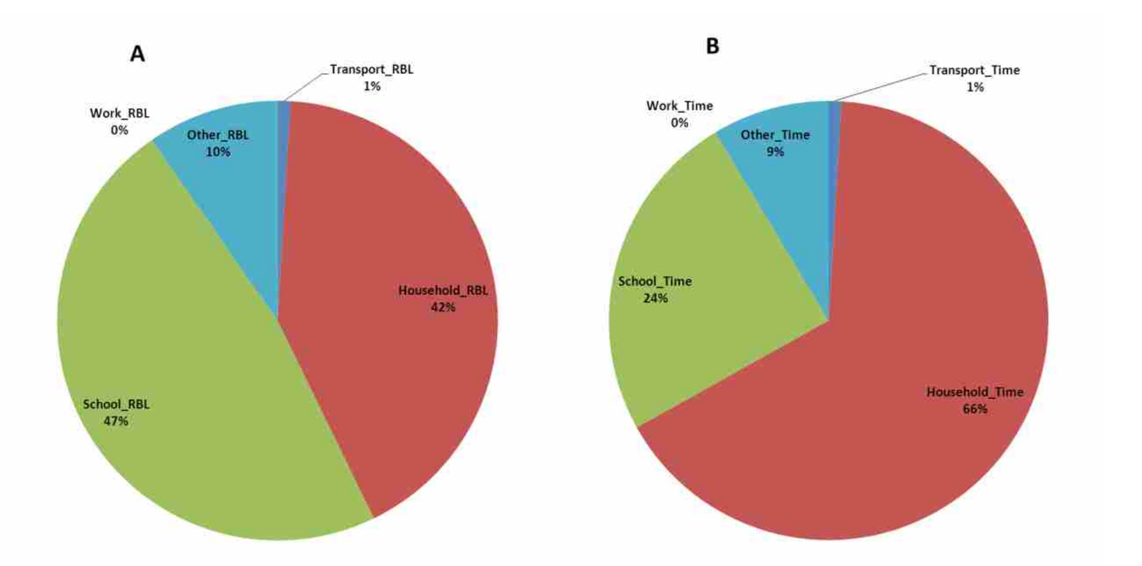
The best way to reduce TB is to eliminate the conditions that are conducive to the spread of TB such as poor ventilation and overcrowding. Particularly as the Education Minister has agreed to promulgate minimum norms and standards surrounding school infrastructure, failing to address ventilation and number of learners per classroom, as well as ensuring that each learner has adequate physical space, shows a clear neglect for the safety and well-being of learners.

VI. Supporting Data from DTHC

In order to determine the locations where individuals may be at greater risk of acquiring TB infection, The DTHC has been conducting a study to quantify the litres of rebreathed air that people are exposed to in their normal daily activities and apportion this air exposure to the different locations visited. A diary of locations that individuals in the study visited, time of arrival and departure at each location and number of people present was kept. The carbon dioxide concentration of the air around the participant was monitored. "Rebreathed litres" was calculated by measuring the net increase in carbon dioxide (CO_2) concentration in the indoor environment, which allowed for the calculation of the amount of CO_2 exhaled by the occupants of the room. Using this measure and the number of occupants in the rooms allows the estimation of exposure to air being rebreathed from other people. This is a good measure of exposure because it is an integrated measure of per person ventilation in the environment with the time spent in that environment.

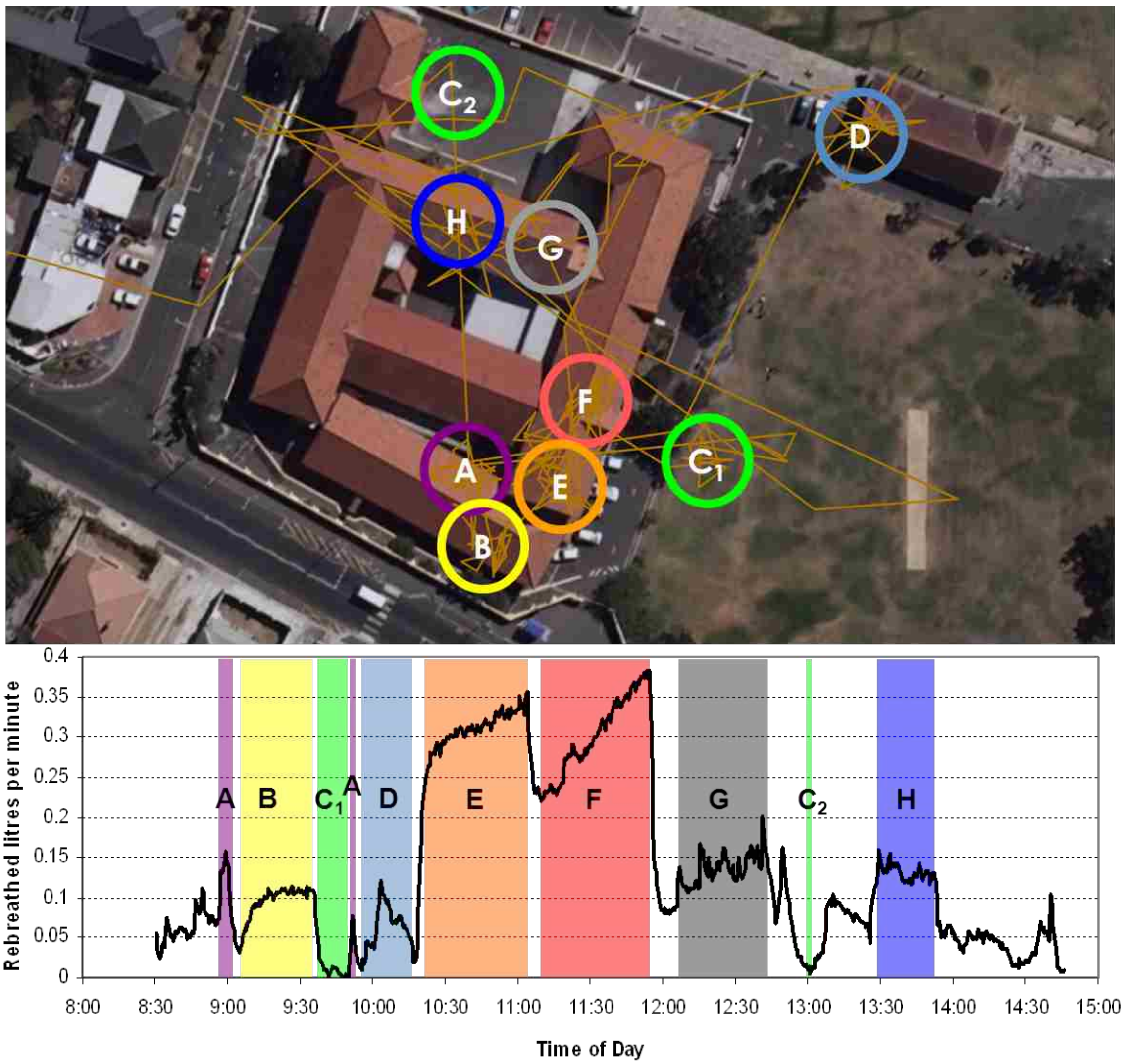
Amongst 21 children (aged from 13 to 21 years old), living in a township setting we have found that 47 per cent of the daily exposure to rebreathed air is occurring at the schools that they are attending. The children are spending on average 24 per cent of their time at school and so it can be seen that their exposure to air from other people is proportionally higher at this location when compared to other locations visited (figure 1). It should be noted that TB risk may not be equal to the rebreathed proportions seen here as the risk of TB does relies on both rebreathed air and the presence of infectious individuals in the environment. The DTHC is developing models that will use these data to elucidate the probabilities of infection at different locations.

Figure 1: Proportion of Rebreathed litres of air from other people at different locations visited by township youth (Panel A) and time spent by the youth at these locations (Panel B).



A high-resolution investigation of one individual attending school showed that the carbon dioxide levels (and thus rebreathed air) in the classrooms was quite variable between classrooms (Figure 2). Some rooms had a very poor ventilation rate as seen by the steep upward slope of the graph while the learner was in class. There is also evidence that some of the rooms (E and F) do not vent sufficiently between classes. The learner was thus exposed to additional rebreathed air resulting from the previous occupants.

Figure 2: A GPS trace of the path of a learner's school day with the superimposed identifiable locations visited, time of day and rebreathed litres of air from others.



These preliminary data show that the ventilation within schools is an important issue that needs to be considered and addressed by The Department of Basic Education when they regulate minimum norms and standards for school infrastructure. These data demonstrate that schools are a primary location where individuals are breathing high levels of rebreathed air, which therefore poses an elevated risk of TB infection when combined with high rates of TB in the population.

VII. Conclusion and Recommendations

Taken together, the scientific evidence discussed in the literature and presented data, and clear directives from the Minister of Health and Constitutional Court demonstrate a clear imperative for the Minister of Education to take seriously the threat of tuberculosis spread in schools and to implement regulations for proper ventilation and prevention of overcrowding in classrooms and other educational spaces in order to protect the health and wellbeing of learners.

VIIa. Recommendation 1: School learning spaces especially classrooms must be properly ventilated.

The importance of establishing requirements for proper ventilation in indoor spaces has been widely recognized in multiple countries for many years (Klauss et al 1970; BRE 2006; WHO 2009) and the American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc. [ASHRAE] issued their first recommendations, Standard 62, in 1973. The most widely accepted standard for indoor ventilation in the United States is the American Society of heating, Refrigeration, and Air Conditional Engineers (ASHRAE) Standard 62. According to this standard, classrooms should be provided with 15 cubic feet per minute outside air per person and a level of 1,000 ppm in schools (Prill 2000) though the Korean EPA mandates that classroom CO_2 levels not exceed 600 ppm. Exhaust fans can also be used to capture and remove pollutants from indoor air.

VIIb. Recommendation 2: School learning spaces especially classrooms must not be overcrowded and must be regulated to ensure that each learner has access to the appropriate amount of physical space.

Extremely overcrowded classrooms pose a safety threat to learners (NPEPA 4.10.1). Classrooms and other learning spaces must be of sufficient size to provide an adequate level of safe air exchange. Classrooms and learning spaces must also not contain more than the maximum number of learners than the room can safely fit and still ensure a safe level of rebreathed air. Classroom size was recognized in the 2008 Norms and Standards, which proposed that regular classrooms must be between 48 to 60 square metres for 40 learners for class while providing for Provinces to choose a suitable class size within the standard range (2008 1.6). MECs are allowed to deviate from this standard given the deviation is both adequate and justified. In this case, deviations would be acceptable if the numbers of learners was small and therefore proper ventilation and lack of overcrowding can still be achieved in the smaller space due to reduced numbers of learners.

In addition to classroom size, norms and standards should include architectural norms such as the maximum ratio of learners per classroom and minimum area per learner as was done in the 2008 draft regulations. Space per learner was mandated in the 2008 draft regulations as 1.2 – 1.5 square metres per learner in ordinary primary and secondary schools and 2.6 for Grade R.

These regulations must apply not only to permanent classrooms and educational spaces but must also apply to temporary structures and spaces used as classrooms.

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