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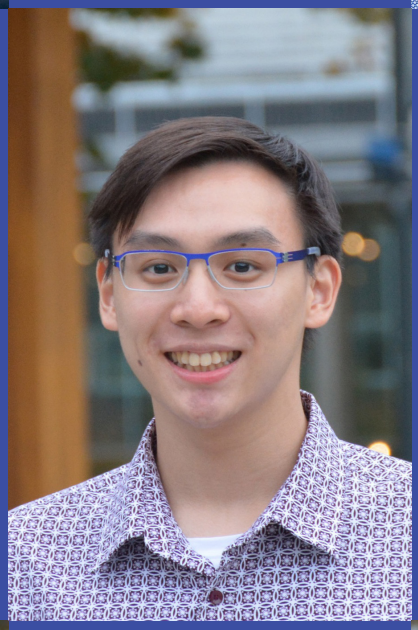

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Letter from the Editor-in-chief

The Canadian Journal of Undergraduate Research (CJUR) is an undergraduate student-driven academic journal with the goal of providing undergraduates across Canada with the opportunity to share their research, experience the publishing process, and engage in multidisciplinary dialogue.

Since our founding in 2015, we have grown as a journal and as a team. Throughout the years, we have communicated with multiple professors and faculty members in the academic community from universities across Canada to receive feedback and advice. With these collaborations, we have immensely improved our submission and publishing process, thus increasing the integrity of CJUR. In the past year, we have reached out to graduate students and professors from universities across Canada to build a credible reviewer database. With our extensive marketing in the past two years, we have built a strong team of editors from universities including University of British Columbia, University of Alberta, McMaster University, and University of Toronto. Through our ongoing efforts, we hope to continue seeing CJUR grow over the years.

This issue includes submissions from the University of British Columbia, University of Victoria, York University, and Douglas College. Each published manuscript has undergone two extensive review stages done by graduate students and professors specializing in the particular field of research. The manuscripts in this issue reflect the efforts undergraduate students put into their work. I hope you will join us in celebrating their work.

It has been a privilege to be a part of CJUR for the past 4 years and watching it grow into the journal it is today. Thank you for your support and I hope you enjoy Volume 4.

Sincerely,
Mahta Amanian
Editor-in-chief

Association between malaria knowledge and bednet use for children under five: Angola malaria indicator survey

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Abstract: Despite distribution of millions of free mosquito nets in Angola, malaria remains the primary cause of mortality in young children, accounting for 35% of deaths among children under five (CU5). Our objectives were first to examine the association between malaria knowledge and bednet use for CU5, and second, to investigate the impact of multivariable logistic regression to analyze responses from a representative sample of women aged 15–49 from the Angola Malaria Indicator Survey (2011). Approximately 44% of respondents with CU5 (n=6,576) owned at least one bednet for sleeping, and of those 87.4% identified mosquitos as a cause of malaria. Adjusting for respondents' age, region, and education, those reporting mosquitos as a cause of malaria had 1.7 (95%CI: 1.3–2.2) times the odds of bednet use for CU5 compared to those not reporting mosquitos as a malaria cause. Exposure to behaviour change communication (i.e. malaria messaging) increased the odds of bednet use where messaging encouraged sleeping under mosquito nets (OR: 1.3, 95%CI: 0.9–1.7). This study provides evidence of a positive association between malaria knowledge and bednet use, indicating that along with widescale distribution of bednets for malaria prevention, public health efforts in Angola should focus on increasing awareness and promoting bednet usage through targeted risk communication.

Introduction

Malaria is the primary cause of mortality in Angola and is the diagnosis of half of all patients in Angolan hospitals (Cosep Consultoria, Consaúde, and ICF International, 2012; Somandjinga, Lluberas, & Jobin, 2009). Over two million cases of malaria arise annually in Angola, and with only eight physicians per 100,000 people, treatment is extremely difficult (World Health Organization, 2011, 2015). Malaria studies in Angola use malaria prevalence to define four geographic regions, which include Hyperendemic, Mesoendemic Stable, Mesoendemic Unstable and the capital city of Luanda. Disparity exists between Luanda and the rest of the country in treatment of this disease. In Luanda, 26% of children were treated with antimalarial drugs compared to only 8% in the Hyperendemic region and 9% in the Mesoendemic Unstable region (Cosep Consultoria, Consaúde, and ICF International, 2012). Furthermore, extreme poverty and the lack of government infrastructure in Angola make treatment inaccessible, and further exacerbates the issue. Despite the influx of wealth into the country through oil production, only approximately $1 USD per capita of Angola's national budget is allotted for malaria control (USAID, 2016). There is a need for the implementation of inexpensive preventative and control strategies against malaria in Angola to better overall national healthcare.

Malaria is an infectious disease caused by a parasite transmitted to humans through the bites of an infected mosquito (World Health Organization, 2015). Bednets are a low-cost, low-tech means of malaria prevention – acting as a physical barrier against mosquitos while sleeping. Malaria-carrying mosquitos feed predominantly at night, and therefore the use of bednets has the potential to greatly limit transmission to humans (Bayoh et al., 2014). A study in Kenya found an increase in bednet ownership and use correlated with an 85% reduction of indoor mosquito densities over a 10-year period (Mutuku et al., 2011). Bednets are available as insecticide-treated and untreated, and while insecticide-treated bednets kill mosquitos on contact, untreated bednets are sufficient as an obstruction to reduce the likelihood of mosquito bites (Mutuku et al., 2011). Bednet costs are low with median prices estimated at $5 USD (Walker, Griffin, Ferguson, & Ghani, 2016).

Malaria in children represent a significant burden of disease in Angola, and accounts for an estimated 35% of mortality in children under five (USAID, 2016). Young children often do not exhibit the typical signs and symptoms of malaria. Instead the disease presents similarly to gastroenteritis, meningitis, or pneumonia, leading to missed opportunities for treatment as detection is often too late, and making children extremely vulnerable to serious malaria infection (Schumacher & Spinelli, 2012). In Angola, a prevention-based method of malaria control through the distribution of free bednets was adopted in 2001. However, uptake has been slow and less than 30% of children under five (CU5) sleep under bednets after a decade of targeted bednet distribution (Cosep Consultoria, Consaúde, and ICF International, 2012; World Health Organization, 2015). Reasons for the low adoption rate are not well understood, and to the best of our knowledge no studies examining CU5 bednet use and malaria knowledge have been conducted in Angola. To gain insight into malaria bednet use in the context of knowledge and understanding of mosquitos as a vector for the disease we used the most recently available Angola Malaria Indicator Survey (2011) and investigated the association between knowledge of malaria cause and bednet use for CU5. The distribution of bednets has been accompanied by education campaigns using various formats such as radio, newspapers, brochures, health promoters etc., and consequently, we were also interested in the influence of malaria messaging on CU5 bednet use and examined this relationship for respondents who had seen or heard particular malaria messages.

Methods

Study design

The Angola Malaria Indicator Survey (AMIS) 2011

was conducted by Cosep Consultoria, Consaúde Lda., and the Programa Nacional de Controle da Malária, and implemented by ICF International under contract with USAID (Cosep Consultoria, Consaúde, and ICF International, 2012). This cross-sectional national survey was conducted from mid-January 2011 through May 2011 and collected data from women aged 15–49, including usual residents and persons staying in the household the night before the interviews were conducted. A multistage randomized cluster sampling methodology was employed and was representative of 8,030 households sampled across the 18 provinces in Angola that had been classified into one of three regional domains depending on the prevalence of malaria in the region: Hyperendemic, Mesoendemic Stable, and Mesoendemic Unstable. The Angolan capital, Luanda, was separated into its own region. In-person interviews were conducted on 8,589 eligible women, yielding a response rate of 98%. A detailed description of the sampling design and interview methods are available in the final report (Cosep Consultoria, Consaúde, and ICF International, 2012).

Analytic sample

To examine the association between correct malaria knowledge and use of bednets for CU5 we analyzed responses from women aged 15–49 with complete data for all survey variables. Of the 8,589 AMIS respondents, those who were not de jure residents were excluded (n = 111), as well as those with no children under the age of five (n = 1,902), individuals living in households not owning at least one bednet (n = 3,697), and individuals with missing data for any study variables (n = 424). The final sample consisted of 2,455 respondents meeting inclusion criteria and providing valid responses to study variables (Figure 1).

Study variables

The dichotomous outcome variable of bednet use for CU5 (yes/no) was taken from the question "Did your child under 5 sleep under a bednet the previous night?". Correct knowledge of malaria transmission was determined using self-reported data and derived from responses to the question "What causes malaria?". Possible answers included: "Mosquitos", "Dirty water", "Dirty surroundings", "Contaminated food", "Witchcraft", "Other", and "Does not know any". These responses, with the exception of "Does not know any", were not mutually exclusive – respondents could indicate more than one cause of malaria. A dichotomous variable for correct knowledge (yes/no) was created by considering any incorrect response as No, and Yes where respondents indicated "Mosquitos" cause malaria.

Potential confounders to the relationship between malaria transmission knowledge and bednet use for CU5 were identified a priori and included: mother's age (5-year age groupings), region (Hyperendemic, Mesoendemic Stable, Mesoendemic Unstable, Luanda), and highest level of education completed (no education, primary education, secondary education or higher). To determine the influence of malaria messaging – targeted communications as part of the bednet distribution campaign – on the use of bednets for CU5 we selected women in the analytic sample who indicated Yes to the question "In the past few months, have you seen or heard any messages about malaria?" (n = 1,218). We analyzed the Yes/No responses for two of the options provided ("Sleep under mosquito nets" and "Malaria kills") to the question "What messages about malaria have you seen or heard?".

Statistical analysis

Descriptive statistics were calculated for the analytic sample by the respondent's age, region of residence, and educational background. Those excluded from the study due to missing responses were compared to those remaining in the analytic sample using chi-square tests to assess potential bias due to missing data. To examine the relationship between correct malaria transmission knowledge and bednet use for CU5 we performed multivariable logistic regression estimating the odds ratio (OR), adjusted OR ($OR_{adjusted}$) and 95% confidence interval (CI). To investigate the robustness of the model to analytic assumptions, an additional analysis was conducted in which a multivariable model was constructed to separate the effects of multiple responses to the question of malaria causes (given that they were not mutually exclusive). All analyses were performed using SAS, University Edition (SAS Institute Inc., Cary, NC), and probability sampling weights provided by AMIS (2011) were applied to all analyses to account for the unequal probabilities of selection and nonresponse (Cosep Consultoria, Consaúde, and ICF International, 2012).

Ethics

The survey protocol was submitted to and approved by the Ethical Review Committee at the National Malaria Control Program and the Institutional Review Board (IRB) of Macro International. Verbal informed consent was obtained from all respondents participating in the survey.

Results

Of the 6,576 de jure AMIS respondents aged 15–49 with children under five, the relative frequency of bednet ownership was 44.1%. Excluding 424 respondents with missing data for any of the study variables, the resulting sample size was 2,455 women (Figure 1). Compared with respondents who remained in the analytical sample those excluded did not differ significantly in the women's age group but were more likely to reside in the Hyperendemic or Mesoendemic Unstable regions ($p < 0.0001$) and have no education ($p < 0.001$).

Table 1 shows the demographics of the overall study sample, as well as the two groups defined by our outcome variable – those women that correctly identified "Mosquito bites" as the cause of malaria and those choosing any of the other possible responses seen in Table 2, except "Mosquito bites". Approximately half of the study sample was under the age of 25. All four malaria epidemiologic regions were represented; however, the highest proportion of respondents resided in the Mesoendemic stable region (40.7%). The majority of respondents had attained only a primary education (64.3%).

Among those in the analytic sample owning one or more bednet, 74.2% indicated that CU5 slept under a bednet the previous night. The frequency of bednet use for CU5

was highest in respondents aged 20–24, those living in the Mesoendemic Stable region, and those with no education.

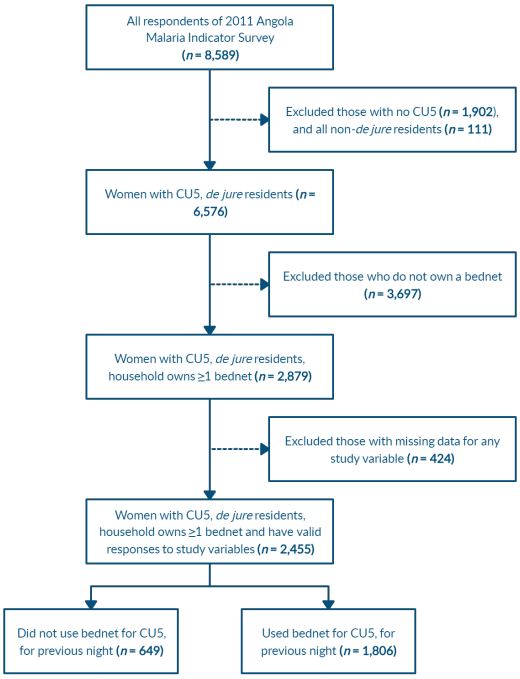

Figure 1: Selection of the final analytic sample from the Angola Malaria Indicator Survey (2011) examining the association between correct knowledge of malaria transmission and bednet use for children under five (CU5)

Malaria causes

When asked the survey question "What causes malaria?", the largest proportion (87.4%) of respondents chose "Mosquito bites" of the seven options provided to them (Table 2). Other possible answers, such as "Dirty needle" or "Contaminated food", represented 1.4%–34.7% of responses. To estimate the effect size for the association between correct malaria knowledge and bednet use for CU5, we used multivariable logistic regression (Table 3), and found increased odds of CU5 bednet use when women had correctly identified "Mosquito bites" as the cause of malaria, with an unadjusted odds ratio (OR) of 1.6 (95%CI: 1.2–2.1). After adjusting for age, region of residence, and education, we found an OR of 1.7 (95%CI: 1.3–2.2).

Compared to the oldest age group (45–49), all ages had increased odds of bednet use for CU5 with correct knowledge of malaria transmission, with the exception of women aged 40–44. We also found an increased odds for residents of all three malaria epidemiologic regions compared to Luanda, with those in the Mesoendemic Stable region having nearly two times the odds of bednet use for CU5 when respondents identified "Mosquito bites" as the cause of malaria. Women with primary level education or less had increased odds of bednet use for CU5 with correct malaria knowledge compared to respondents who achieved secondary or higher education.

Because the AMIS survey permits respondents to select multiple responses to the question regarding the cause of malaria, we investigated how these multiple responses might affect our conclusions. We redefined the explanatory variable, adding a Maybe category to capture the respondents who selected "Mosquito bites" in addition to any of the other five possible causes of malaria. The main effect estimate for the redefined Yes category yielded a marginally higher odds ratio of 2.0 (95%CI: 1.5–2.6), and the new category of Maybe returned a marginally lower odds 1.4 (1.1–1.9) of bednet use for CU5.

Malaria messaging

Only 49.9% (n = 1,218) of women indicated they had seen or heard messaging (any media format e.g. radio, newspaper) regarding malaria. Of these women, 56.2% (n = 660) received messages to "Sleep under mosquito nets", and even less (37.3%) had seen or heard messages indicating that "Malaria kills". We found that the odds of bednet use for CU5 was increased for respondents indicating that they had seen or heard messaging regarding the use of mosquito nets, whereas the odds of bednet use for CU5 was decreased for those who had received messages that malaria kills; however, the 95% CI crossed '1' in both instances (Table 4).

Discussion

The present study utilized the Angola Malaria Indicator Survey (2011), with data collected from more than 8,500 women, to investigate the relationship between knowledge of malaria transmission and use of bednets for children under five (CU5). Our study demonstrated in a representative population-based sample that correctly identifying mosquito bites as a cause of malaria was independently associated with an increased odds of bednet use for CU5 ($OR_{adjusted}$ 1.7, 95%CI: 1.3–2.2), and recent malaria messaging had little if any impact on use of bednets for CU5.

Our finding that correct knowledge of malaria transmission positively correlated to bednet use is consistent with studies conducted in other malaria-endemic countries in which malaria knowledge was assessed (García-Basteiro et al., 2011; Hwang et al., 2010), and our analysis yielded a nearly identical adjusted odds ratio – lending support to our conclusions. Additionally, we found those residing in any malaria-endemic region of Angola had increased odds of bednet use for CU5 with correct understanding that mosquito bites cause malaria compared to the capital of Luanda. This may be the result of targeted free bednet distribution in these regions and the information, education and communication strategies that have been paired with distribution (USAID, 2016). Yet, when examining the data collected around behavior change communication i.e. malaria messaging, delivered as part of the bednet distribution campaign, the results were mixed. Those that received information to sleep under mosquito nets had increased odds of bednet use, whereas those that had heard or seen messages that malaria can cause death had lower odds of bednet use for CU5. This is in contrast to a study in Ghana examining malaria messaging in which participants had more than three times the odds of bednet use in CU5 when they had received information regarding malaria (Owusu Adjah & Panayiotou, 2014). However, they did not analyze messages individually and may not be directly comparable to our findings.

The national sampling methodology of the AMIS resulted in a large survey dataset representative of the Angolan population and is a strength of this study. However, two

important limitations should be discussed. First, the data was self-reported and due to social desirability respondents may have falsely statedto the interviewer that CU5 had slept under a bednet the previous night. If more respondents with correct knowledge of malaria transmission incorrectly reported bednet use this would have resulted in an overestimate in the odds ratios we observed. Given the survey questions were adapted to the local situation and interviewers were fully trained (Cosep Consultoria, Consaúde, and ICF International, 2012), we expect this to be limited; however, it cannot be dismissed as a source of bias. Second, the question of bednet use for CU5 was restricted to use the previous night. While reducing issues of recall, the response to this question does not represent regular use and may limit the generalizability of our findings with respect to consistent bednet usage. It should be noted that studies in which information was collected for both regular use of bednets as well as the previous nights' use have found similar proportions among study participants (Animut et al., 2008; Xu, Liao, Liu, Nie, & Havumaki, 2014). Despite these limitations, this study provides the first evidence on the use of bednets for Angolan CU5 in association with knowledge of malaria transmission and indicates that understanding mosquitos are associated with malaria may increase bednet use. Yet, in spite of mass distribution campaigns that have included information and education regarding malaria, our findings suggest that the current communication on malaria risk have had little effect in promoting bednet use for CU5. The Precaution Adoption Process Model (PAPM) describes stages of health-related behaviour adoption – from being unaware of an issue (stage 1), to aware but unengaged (stage 2) through maintaining a health behaviour (stage 7), and provides a framework to develop risk communication strategies focused on changing perceptions and encouraging uptake of preventive health behaviours (Weinstein, 1988). Here, the desired action is use of bednets for young children. With nearly a quarter of respondents owning but not using a bednet for CU5, and more than half of respondents indicating they had not heard the message that "Malaria kills" it is likely that a significant proportion of individuals remain in stages 1 or 2. To increase awareness and ensure messages address specific beliefs and attitudes of a population, additional research is needed to determine the best delivery format.

In conclusion, findings from our study suggest there is a considerable gap between bednet ownership and use for CU5. Correct knowledge of malaria transmission through mosquito bites was associated with increased odds of CU5 sleeping under a bednet the previous night. With bednet ownership at less than 50% of households surveyed it is imperative that free bednet distribution campaigns continue. However, our findings with respect to malaria messaging indicate more work may be needed in this regard as it is important to not only increase the availability of bednets but ensure their use through increased awareness of the preventive steps that can be taken to protect those at highest risk.

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	Overall		Bednet use	
			Yes (%)*	No (%)*
	n = 2,455	%*	*n* = 1,506 (74.2%)	*n* = 649 (25.8%)
Age group				
15–19	557	24.0	74.8	25.2
20–24	641	26.1	77.2	22.8
25–29	478	18.8	73.9	26.1
30–34	305	12.2	75.4	24.6
35–39	279	10.9	72.1	27.9
40–44	126	5.2	62.4	37.6
45–49	69	2.8	70.3	29.7
Region				
Hyperendemic	467	16.1	75.6	24.4
Mesoendemic stable	651	40.7	79.3	20.7
Mesoendemic unstable	641	18.3	72.5	27.5
Luanda	696	24.9	66.3	33.7
Education				
No education	441	16.7	76.8	23.2
Primary education	1,565	64.3	75.0	25.0
Secondary education or higher	479	19.0	69.3	30.7

**Percentages are weighed to account for the multistage stratified sampling strategy*

Table 1: Characteristics of the analytic sample, examining the association between correct knowledge of malaria transmission and bednet use in children under five, Angola Malaria Indicator Survey (2011).

Responses†	Number	Percentage (%)*
Mosquito bites	2,122	87.4
Dirty environment	737	28.7
Dirty needle	866	34.7
Contaminated food	270	10.5
Witchcraft	51	1.9
Other	36	1.4
Does not know any	192	7.0

**Percentages are weighed to account for the multistage stratified sampling strategy*
†Not mutually exclusive; participants could select more than one response, with the exception of 'Does not know any'

Table 2: Responses to "What causes malaria?" in the study population, Angola Malaria Indicator Survey (2011).

	OR (95% CI)	$OR_{adjusted}$ (95% CI)
Bednet used for CU5		
Yes	1.6 (1.2–2.1)	1.7(1.3–2.2)
No	Reference	Reference
Age group		
15–19	1.3 (0.7–2.3)	1.3 (0.7–2.4)
20–24	1.4 (0.8–2.6)	1.5 (0.8–2.8)
25–29	1.2(0.7–2.2)	1.3 (0.7–2.5)
30–34	1.3(0.7–2.4)	1.4 (0.8–2.7)
35–39	1.1 (0.6–2.0)	1.2 (0.6–2.2)
40–44	0.7 (0.4–1.4)	0.7 (0.4–1.5)
45–49	Reference	Reference
Region		
Hyperendemic	1.6 (1.2–2.1)	1.6 (1.2–2.1)
Mesoendemic stable	1.9 (1.5–2.5)	1.8 (1.4–2.4)
Mesoendemic unstable	1.3 (1.1–1.7)	1.3 (1.1–1.7)
Luanda	Reference	Reference
Education		
No education	1.5 (1.1–2.0)	1.4 (0.9–1.9)
Primary education	1.3 (1.1–1.7)	1.2 (0.9–1.6)
Secondary education or higher	Reference	Reference

OR – odds ratio, CI – confidence interval

Table 3: Logistic regression analysis for the association between women with correct knowl-edge of malaria transmission (Yes vs. No) and bednet use for children under five (CU5), Angola Malaria Indicator Survey (2011).

Malaria messaging	Overall	Bednet used		Bednet used 'Yes' *vs.* 'No'
		n (%)* 'Yes'	*n* (%)* 'No'	OR (95% CI)
	n = 1,218	*n* = 1,806 (74.2%)	*n* = 649 (25.8%)	
Sleep under mosquito nets				
Yes	660 (56.2)	512 (77.7)	148 (22.3)	1.3 (0.9–1.7)
No	558 (43.8)	418 (73.2)	140 (26.8)	Reference
Malaria kills				
Yes	481(37.3)	370 (75.0)	111 (25.0)	0.9 (0.7–1.3)
No	737 (62.7)	560 (76.2)	177 (23.8)	Reference

OR – odds ratio, CI – confidence interval
**Percentages are weighed to account for the multistage stratified sampling strategy*

Table 4: Univariable analyses of the relationship between malaria messages seen or heard and bednet used (Yes vs. No) for children under five, Angola Malaria Indicator Survey (2011).

Community clozapine monitoring protocols: Review of vital sign monitoring requirements in supporting the first two days of community clozapine initiation

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Abstract: Clozapine is a crucial antipsychotic medication to treat schizophrenia and has shown valuable benefits in doing so. However, there can be rare, but potentially fatal adverse drug reactions to the medication. Therefore, it is essential that there is careful monitoring of the patient while on the medication. A retrospective study was conducted to examine the effects of clozapine on vitals during the first 2 days of initiation. There were 43 (29 male, 16 female) charts analyzed retrospectively, and the average age of the patients was 45 years old. The average dose of clozapine on the first day was 9.3mg and 15.7mg on the second day. Regarding vitals, the temperature peaked 5 hours after administrating clozapine on day 1 and day 2. Furthermore, the respiration rate peaked 4 hours post-dose on the second day and the heart rate increased the most on the second day indicating a dose-related response. There was no trend in blood pressure changes that can be inferred from the data; however, individual variations in blood pressure fluctuated considerably. The study was limited due to a lack of data in patient charts, and it may be of interest to do a prospective study to gain more insight.

Introduction

Clozapine is a unique, atypical antipsychotic medication that is effective for treating the positive and negative symptoms of schizophrenia (McEvoy et al., 2006). However, it may cause severe side effects such as agranulocytosis, seizures, cardiovascular/respiratory arrest and myocarditis (Merrill et al. 2006; Miller 2000). In fact, approximately 8.1% of patients are taken off therapy due to a serious side effect (Grohmann, 1989). There are significant side effects with treatment, and it is essential to treat schizophrenia effectively as it is a severe mental disorder that can cause considerable disability such as delusions, hallucinations, problems with concentration, and a lack of motivation among other debilitating aspects.

This study aimed to determine the effects of clozapine on patient's vitals during the first two days of dosage titration and if there is an appropriate amount of monitoring while at a community initiation of therapy. Currently at the Fraser Health Psychosis Treatment Optimizing program (PTOP), patients starting clozapine have their blood pressure (standing and lying), temperature, pulse, and respiration measured before dosage administration, 15 minutes, one hour, two hours, three hours, four hours, five hours and six hours post-dose for the first two days of therapy (Fraser Health Authority, 2015). Such intense monitoring can make it difficult for providers to follow and increases the amount of laborious monitoring towards the patient.

Although there are significant and life-threatening side effects associated with clozapine, there are no evidence-based monitoring plans (Canadian Agency for Drugs and Technologies in Health, 2010). Furthermore, monitoring guidelines across the world were examined to determine if a trend could be found. The Commonwealth regions (New Zealand, Australia, Wales, Manchester) and California were investigated and found no consistent monitoring patterns between the regions.

When the health authorities were contacted for the rationale behind the guidelines they described it as being based on drug monographs and Maudsley's prescribing guidelines (11th edition). When examining the Maudsley's recommendation, it suggests to either give the first dose in the morning and monitor for 3 hours or give the first dose in the evening before retiring to avoid monitoring (Taylor et al., 2015). The drug monograph recommendations are based on an expert panel review board and are very similar to Maudsley's monitoring proposals (O'Brien 2004, and. Novartis Pharmaceuticals, 2003). Thus, the current drug monitoring guidelines within the Fraser Health Authority significantly err on the safer side when compared to other literature sources of clozapine monitoring.

Methods

Between the period of 2012-2015, a retrospective review of PTOP clozapine therapy initiation within the Fraser Health was examined for vital sign data (blood pressure, respiration rate, heart rate and temperature). The study searched for any changes in blood pressure and heart rate at each of the current monitoring intervals; the monitoring levels are attained at baseline 15 minutes, one hour, two hours, three hours, four hours, five hours and six hours post-dose for the first two days of therapy). Furthermore, demographic information for confounding was also examined such as medication, age, comorbidities, sex, prior exposure to clozapine, blood work, and ECG monitoring.

All data were examined for means, standard deviations, and missing information. Furthermore, data collection was analysed for consistency in recording of data, clinician accuracy and discrepancies. In addition, bias was also examined such as in areas of selection, design, response, reporting, and measurement. Starting dose clozapine was also evaluated. The primary objective of this study was to determine any changes in vital signs associated with clozapine initiation in the first two days and the time of peak effect. The secondary goal was to determine if there are patient factors (e.g. age, gender, ethnicity, number or type of concurrent medications) that are associated with any observed changes

in vital signs.

Results

Demographics

There were 174 patients made up PTOP, but n = 131 were excluded, leaving 43 charts to examine in this study. The patients were excluded due to a lack of patient monitoring information. There were 29 male and 16 female patients, and the average age was 45 years old. The mean dose on the first day was 9.3mg and the average treatment dose on the second day was 15.7mg. All available past substance and medication history were collected (Table 1 and 2). Table 3 shows pre-existing risk factors and comorbidities of the patient. It is important to note that due to the nature of data collection Tables 1, 2, and 3 are anticipated to be incomplete (retrospective study).

Temperature

Temperature peaked at 5 hours post-dose for both days 1 and 2. The maximum temperature for a patient was 37.6˚C, and the minimum was 34.1˚C with a standard deviation of 0.60. Refer to Figure 1 for the graph of temperature.

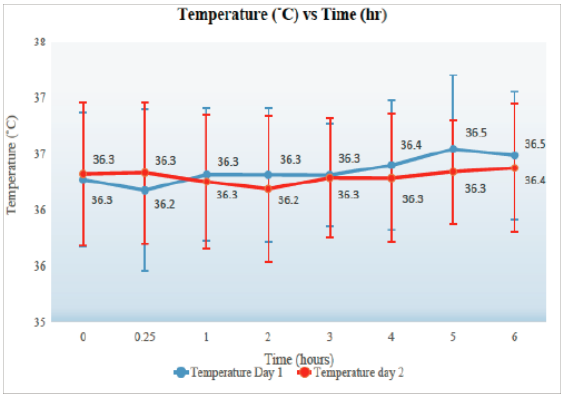

Figure 1: Average temperature at each vital monitoring time (n = 43)

Respiration

The maximum respiration rate recorded was 30 breaths/minute, and the lowest was 10 breaths/minute. The standard deviation is 2.5. The respiration for Day 2 spikes at the 4th hour, 19 breaths/minute, and appears slightly higher than the first day. Refer to Figure 2.

Heart rate

Figure 3 shows the maximum heart rate was 121 beats per minute (bpm) and the minimum was 49 bpm. The lying heart rate standard deviation for the patient population is 13.9 bpm. The peak in pulse appears to occur between hours 3.5-5.5. The second day seems to have a more significant increase in heart rate compared to the first day. Figure 4 shows the maximum average heart rate change from lying to standing and occurs at hour 3 in Day 1, 17.1 bpm, and the lowest average change occurs at hour 2 in Day 1 (8.4). The standard deviation of the averaged data is 2.5. The maximum individual change occurred was 53 bpm, and the lowest was – 11 bpm (decreased by 11 bpm from lying to standing). The number of patients consisting of these values had a low statistical power and the number of patient data at each time interval ranged from 11 to 6. Thus, examining the lying to standing changes may be difficult to make a definitive conclusion as the data is insufficient.

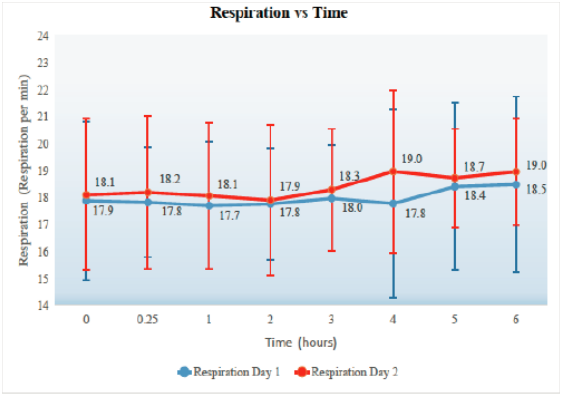

Figure 2: Average respiration rate at each vital monitoring time (n = 43)

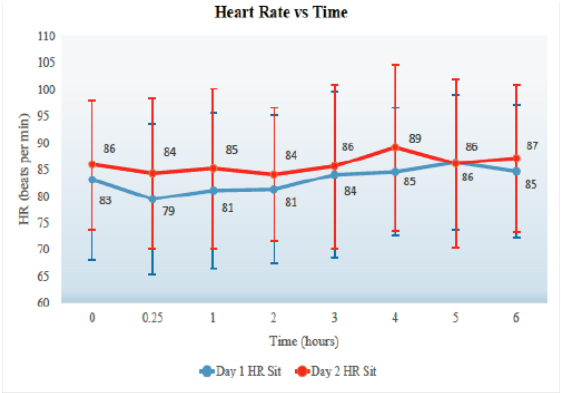

Figure 3: Average heart rate while patient is sitting at each vital monitoring time (n = 43)

Blood pressure

Challenges exist in the measurement of blood pressure, as the values can range depending on the practitioner technique (i.e. manual vs automatic) and the device itself (Mansoor et al. 2016). When examining for a trend in blood pressure changes, there did not appear to be a large difference. However, the averages oversimplify the differences for each patient. The individual changes ranged from an increase of 37 mmHg to a decrease of 39 mmHg when measuring blood pressure from a lying to standing position; Table 4 displays the variance for individual patients.

Discussion

The study took data from sites that were following guidelines implemented prior to August 2016 and examined available patient charts for monitoring data. Temperature, respiration rate, and pulse have a distinct peak centred around 4 hours with a range of 3-6 hours. The temperature did not rise above 38˚C in any of the patients (n = 43) between pre-dose and six hours post-dose (for days 1 and 2). Heart rate and the temperature had a greater increase on the second day. It is important to monitor temperature as fever is a risk factor for agranulocytosis and Neuroleptic Malignant Syndrome (NMS) (Novartis Pharmaceuticals, 2010; Young et al., 1998). Temperature elevation (>38˚C) is associated to have a peak incidence within the first three weeks of treatment. However,

it is usually benign and self-limiting (Novartis Pharmaceuticals, 2010; Young et al., 1998). Therefore, elevation of temperature is not a good reason to stop therapy when examining just that parameter (O'Brien, 2004).

The effect of clozapine on heart rate elevation is that it may be a risk factor for myocarditis and cardiomyopathy (Safferman et al., 1991). However, the reports of myocarditis are rare and tachycardia (bpm > 100) occurs in 25% of all patient (Novartis Pharmaceuticals, 2010). Most commonly, monitoring heart rate is used to assess compliance and mild elevations of pulse is not significant enough to discontinue therapy (O'Brien, 2004). However, when the heart rate increases 30 beats per minute from baseline it may be a significant health concern.

When examining the average respiratory rate, the rate did not increase by more than one breath/minute in day 1 or day 2. When monitoring breathing rate, the primary concern is oversedation and respiratory collapse (O'Brien, 2004). However, it is rare to occur but, should be monitored closely when benzodiazepines are involved or other central nervous system depressants (Novartis Pharmaceuticals, 2010).

Blood pressure monitoring is the most significant vital to measure during clozapine initiation. Orthostatic hypotension has a 9% incidence and is dose-related (Marinkovic et al 1994; Safferman et al., 1991). Also, orthostatic hypotension is most likely to occur during the initial dose titration (California Correctional Health Care Services, 2017). Approximately 1 in 3000 patients experience collapse and respiratory or cardiac arrest when on clozapine (Young et al., 1998). The most significant blood pressure change occurred on the second day (dose dependent). For example, the blood pressure changes ranged from an increase of 39mmHg to a decrease of 39 mmHg. Thus, blood pressure varied quite considerably and averaged data can oversimplify these changes. It may be a health concern when the blood pressure deviates greater than 20 mmHg from baseline. Due to the high incidence of orthostatic hypertension and considerable blood pressure fluctuations, it is of particular importance to measure blood pressure over any other parameter during the first two days of a clozapine start.

Heart rate also had the most change on the second day (dose-dependent) and occurred between 3.5-5.5 hours. The pulse was noted to increase steadily after administering clozapine. However, there was not enough data to show a statistical difference.

There are several limitations to this study that should be considered. Due to an under recording of vital sign data and lack of complete health practitioner charts, there is a shortfall of information. It may be of interest to do a prospective study to gain further insight prior to implementing any recommendation. Only ~1/4 of charts contained some form of vitals monitoring data. The charts used had incomplete vital recordings and patient background, and thus, there is likely to be bias in the data (only certain nurses recorded and properly filed the vital sign data). Furthermore, there was weak statistical power in the study (n = 43).

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Criminalization of minority youth in the youth justice system in Canada

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Abstract: Despite the immense amount of research completed on adult correctional facilities within North America, little is known about the overrepresentation of visible minority youth within the juvenile justice system. The juvenile justice system is known for violent juvenile offenders, who become and remain habitual offenders. The juvenile justice system then faces questioning for creating professional criminals instead of focusing on effective rehabilitation. The face of the youth justice system within Canada is rapidly changing. Increasing forms of diversity serve as a principal pattern because the criminalization of minority youth occurs from cultural incompetence, unawareness, and insensitivity. This article recovers the institutional or systemic forms of treatment that minority youth face within the criminal justice system. It also further shows that there is little focus on the experiences of minority youth within juvenile correctional facilities due to a lack of information. Racialized and marginalized youth and young adults are apart of the vulnerable population within Canada. One must ensure that youth and young adults who are vulnerable within society, receive the best possible chance at achieve upward mobility. The youth justice system, from a racial justice lens, reveals slave-era origin within youth prisons, limiting opportunities for racialized youth across Canada. Racial antagonism within the youth justice system leads to the criminalization of minority youth, which serves as a foundation for why culture shapes the identity of racialized youth.

The criminalization of minority youth in the youth justice system within Canada is often ignored (Ming Kwok et al., 2017). There are a wide range of effects related to race, that show the general public that although we live in a racially diverse nation, certain communities become marginalized. Racism is defined as an individual act or classified as an institutional practice that can perpetuate inequality, due to racial association (Calgary Anti-Racism Education, 2015). Persons of colour may face different treatment when dealing with the entire range of Canada's juvenile justice system (Ward, 2011). Racial imbalance within the juvenile justice system is existent when the percentage of individuals from a specific racial group is greater than the amount of other racial groups, in the general population (Soung, 2011). This can lead to disparity. Disparity within the justice system can refer to a situation where individuals from different ethnic groups have different perspectives on certain outcomes, which can turn into overrepresentation of racialized youth in the juvenile justice system. One can state that unwarranted and illegitimate forms of racial disparities within the juvenile justice system results from differential treatment that some individuals face, due to their ethnicity. This could include overt forms of discrimination, as racial imbalances result from individual or institutional forms of race-based discrimination. The racial imbalance within juvenile facilities is treated as a predicament, at best as a consequence of the cultivation of impoverishment (Kishna, 2014). Maureen Kishna, in a study on combatting racial disparities within the juvenile system, stated:

> *There is an imbalance in our nation's juvenile justice system that is not a secret known only within communities of colour. The painful reality that many families have perceived and grappled with is that black and Latino youth are more likely to be arrested than their white peers. This has been well documented over the years. Black youth are less likely to be diverted, more likely to be sentenced to secure facilities and even more likely to be transferred to the adult system. Disparities exist at nearly every point in the juvenile justice system* (Kishna, 2014, p.2).

Racial imbalances can differ based on different levels of criminal activity, can include different emphasis on criminality by police units, and policies and decisions made by individuals within the criminal justice system (Jackson et al., 2000). It is important to include racial imbalances within this important subject because racial imbalances challenge the values and beliefs that the justice system rests upon. It eliminates equal justice for everyone, as the justice system becomes unfair instead of fair. When the physical nature of discrimination is ignored within conversations about the rising rate of incarcerated youth and delinquency, it serves as a presumed "Negro domination" on law breaking (The Sentencing Project, 2008). Negro domination was a term coined by white supremacists throughout the early 1900s, in order to preserve Whiteness. Negro domination has always been a term used in order to supress the upward mobility of the Black population, in order to allow Whites to maintain as the superiors within society. Due to a disproportionate amount of racialized youth within juvenile facilities, it can be noted that racial imbalances are now consequences of overt bias within the criminal justice system. As long as racism is in existence in society, it will continue to be within the juvenile justice system, as there is a strong need to address, reduce and eliminate overt forms of racism that flourish in subtle methods. In order to achieve this, one needs to understand racialization. Racialization is the process or act of treating a person, relationship, or group differently through racial terms, as their abilities and values could be different from yours (Gans, 2016).

Delinquency

Delinquency is one of the most prevailing issues in which racialized and marginalized Canadian youth engage. It has become increasingly obvious that information surrounding juvenile delinquency is of importance, especially when it affects vulnerable communities. It is important to understand what delinquency is, as it can help us understand

why racialized and marginalized youth, represent the highest rate of juvenile delinquents. It is believed that over one-third of Canadian youth have been involved within some sort of criminal act by the age of fifteen (Satzewich and Shaffir, 2009). Also, approximately 5% of Canadian youth have been charged and incarcerated with federal offences (Tanovich, 2008). There is a multitude of trajectories that result in delinquency for youth that heavily influence their likelihood of engaging in criminal forms of behaviour (Kishna, 2014). The developmental period of adolescence tends to be sensitive, which greatly impacts their development and the way that they mature. This then leads into the future of their well-being, as certain capacities and behaviours shapes the childhood of youth as they develop into adulthood (Kishna, 2014). Youth who are classified within the high delinquency category often have hostile demeanours, conflicting disobedience, and are uncontrollable (The Sentencing Project, 2008). Juvenile delinquents that are labelled as volatile and dangerous, should receive supportive networks, resources, and education in order to combat stereotypes that are made towards them. Having a great support network from peers and families throughout their adolescent development, will help them to achieve short term and long term goals. This leads to family risk dynamics, which include public housing, limited parental literacy, and single guardianship. This is of importance because social factors play a large role when it comes to youth crime, and the influences that youth face. There is a need to have a cohesive community, with positive role models who are able to supervise youth activity. This could lead to the reduction of crime, enabling positive group interactions between beers, which could be important for eliminating criminal activity.

Through a cultural and identity aspect, minority youth are not only offenders in crimes, but are victim to the juvenile justice system in Canada, due to overt and covert forms of prejudice. The overrepresentation of young people of colour within the juvenile justice system in Canada alerts examination about equality of treatment and equality for minority youth by police organizations, members within the juvenile and criminal justice system, and judiciary. The juvenile justice system experiences overrepresentation at various different stages, as the proportion of a certain population or ethnic groups exceeds the proportion of the general population. Carl James (2002), an educator within the Faculty of Education and the Department of Sociology at York University believes that the life experiences of minorities are based on racial stereotyping and profiling. Throughout the juvenile justice course of action, one can view that race may partially explain why minority youth continue to prevail within the justice system.

Delinquency of racialized youth

There are major disparities when it comes to delinquency and the involvement of racialized youth, in comparison to White youth within the juvenile justice system. When one looks at the disproportionate rate of ethnic representation, it can raise various questions regarding fairness and equality by individuals who are connected to the juvenile justice system. The courts, police, and other institutions should be questioned about their association with racialized youth and the consequences that could occur for the future. Systemic discrimination may play a significant role, as racialized youth within Canada face higher rates of unemployment, community violence, family challenges, and poverty compared to their White counterparts Rankin and Winsa (2013). Once an arrest is made, a systemic cycle is created towards disadvantaged racial youth, as it is well known that minority youth are grossly overrepresented throughout the Canadian criminal justice system. Rankin and Winsa (2013), stated within their article entitled "Unequal justice: Aboriginal and black inmates disproportionately fill Ontario jails" that:

> *Young black men face racism, poverty, lack of opportunity, social isolation, violence in their neighbourhoods, family challenges and unemployment. Once these men are known to police, systemic issues stack the deck against already disadvantaged groups, say academics and a library of past research, including the 1995 Report of the Commission on Systemic Racism in the Ontario Criminal Justice System* (Rankin and Winsa, 2013, para. 23 & 24).

Correctional facilities for youth and adults have become a continual and predictable headline of our collective existence. Correctional facilities have become such a daily part of life that we cannot possibly imagine a successful society without one. Throughout the years there has been an increased amount of racialized and marginalized communities within correctional facilities. It then raises the question of whether Canada should provide better substitutions than offering the foreseeable prison sentence.

Racialized and marginalized youth are then viewed as individuals who continue to complete delinquent forms of activity, which causes society to formulate biasness and prejudice against racialized populations. Rankin and Winsa (2013) also noted that,

> *Black people go to jail for possessing and selling crack cocaine. White people who sell and use cocaine powder rarely do …White people get all of the discharges and conditional sentences for illegal possession of firearms; black people go to jail. Name any essentially similar offence and the case law always seems to find it more serious when a black man commits it* (Rankin and Winsa, 2013, p. 31 & 32).

This is dangerous because individuals involved within policies and legislature do not feel the need to tackle problems within the juvenile justice system. What apparently matters most to the Canadian government is decreasing the amount of criminal activity that is occurring. Through decreasing criminal activity, the Canadian government aims to eliminate it completely - it is assumed that incarceration is the answer. Getting rid of individuals who are classified as criminals due to societal norms and their ascribed status continues the narrative that racialized youth should receive harsher treatment than their White counterparts throughout the process of the juvenile justice system. It is important to acknowledge that institutional forms of discrimination within the juvenile justice system will cause a rapid percentage of young racialized and marginalized youth to spend a large allocation of their lives within correctional facilities.

This is because anti-racist policies have not been formulated to ensure fair and adequate justice for the majority and the minority in a multicultural nation.

The direct surveillance of the juvenile justice system within Canada is the cause of the racialized impact of racialized and marginalized youth drawn into the juvenile system (Tanovich, 2014, 20). The racial imbalance of cultural populations is not deemed as institutional or structural discrimination, but rather is summoned as a consequence for the illegality of racialized and marginalized youth within Canada (Tanovich, 2014, 21). Society needs to acknowledge that racism is deeply entrenched within the process of criminalization. Discrimination and prejudice that has been practiced by the justice system has allowed racial profiling to increase (Tanovich, 2014). Racial profiling is when law enforcement officials target racialized, marginalized, and low-income civilians for suspicion of crime. The practice of racial profiling completed by individuals within the justice system is usually covered up as it relies on individual discrimination, stereotypes, and prejudice in order to protect communities safely with security. Racial profiling is the status quo for a lot of minorities within Canada (Calgary Anti-Racism Education, 2015). This disproportionate interaction between the criminal justice system and minorities, which is unfair and illegitimate, creates mistrust within the legal system. White institutional or systemic forms of discrimination are visible within neighbourhoods, regions, institutions and families. Most importantly, it is visible when members of law enforcement such as the police, who are the most visible representation of the justice system, interact with low income and communities of colour. A victim to police brutality stated on a poster:

> *Police officers are trained to handle the law, not abuse it. Having a bad day is not an excuse for brutality, and obviously the people saying this have never experienced forms of police brutality. If you are a police officer that has a bad day every now and then and senselessly beats citizens, sometimes using weapons against them, and in some cases killing them, you SHOULD NOT be a police officer* (Victim of Police Brutality, September 2012).

The dominant growth of police agencies assisted by the perseverance of discrimination continues to increase and support racist practices that promote the criminalization of minority youth. The product of resent that is gradual becomes frustrating because of the injustices that are faced within minority communities. It is considered as the most harmful consequence generated from the Canadian Criminal Justice System as racial injustice is disregarded within the Charter (Tanovich, 2014). One might possibly ask why culture and race is significant? The institution of prison has allowed for perplexing challenges to occur for minority youth who have become accustomed to its existence.

Hirschi (1969) further believed that it was important to ask the question, "Why do they do it?". Hirschi wanted to show how effective the juvenile justice system was and if it was possible for juvenile delinquents to stop offending as adults, becoming non-delinquents. This further allows social control theory to introduce the act of social bonds (Hirschi, 1969). A social bond is bonding ties to the institution of family. Through bonding ties to the family the institution of education, the workplace, and community is included. Through the integration of society, one's social bond can vary. The explanation of social bonds allows society to understand why not everyone completes criminal activity, which can further question our non-involvement when it comes to dismantling over and under policing of racialized communities. Through an individual's bonds they either face limitations or advantages to completing deviant forms of behaviour. When an individual has strong bonds to society, their intention on completing criminal forms of activity are limited (Hirschi, 1969). When an individual has weak bonds, the likelihood of completing delinquent activity increases drastically (Hirschi, 1969). Through the discussion of social bonds, an individual having weak bonds to society is not a justification to delinquency. It does however allow delinquent behaviours to occur within society, which can halter their upward mobility.

The overrepresentation of racialized and marginalized youth within the Canadian juvenile justice system is not only important, but requires attention immediately. There are risks that come along to the disproportional ethnic representation. These risks raise concerns of unfairness and unequal treatment of Black and Latino youth by the court, police force and other individuals within the justice system in Canada. There also needs to be more research that demonstrates an understanding of the various factors that continue to contribute to racial imbalances and ethnic discrimination within the juvenile justice system. There is a huge problem within the juvenile justice system in Canada and a focus of crime, race, and the juvenile justice system needs to be addressed. I believe that a long-term plan that addresses systemic and institutional issues of the juvenile justice system can reduce racial imbalance. When the Canadian government can create a plan combatting this issue with funding, researchers can examine the juvenile justice system at all stages. There can be an examination of policy and practice within the production of juvenile arrests, sentencing, and confinement, as well as a focus on biasness within the juvenile justice system. When the Canadian government pays attention to this issue we can examine how racialized and lower income youth are victim to racial disproportionality because of their communities, gender, and racial origin.

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Fighting fire with fire: Why harsher punishments for young female offenders are not the answer

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Abstract: Female juvenile crime is on the rise. In response, some agencies are suggesting a remedy to revise the Canadian Youth Criminal Justice Act in favour of harsher sentences for youth. This paper delves into the potential negative repercussions of said amendment such as increased involvement in gangs and deteriorating mental health. Furthermore, alternative methods such as after school programs, mentorships, and therapeutic means of rehabilitation are shown to not only be more effective for reducing crime among young women but more cost effective as well. Prisons have been shown to worsen the situations of young women who have grown up in extremely disadvantageous circumstances. Thus, this paper argues that harsher sentences for female youth will not only be ineffective in solving the current problem of female youth crime but may make it worse.

Introduction

Young women have not always been a popular topic of discussion among criminologists. Although there has been limited research on young women in the criminal justice system in the past, a 1993 study showed that law enforcement agencies in the United States made an estimated 570,100 arrests of women under the age of 18, a 3% increase since 1983, and more recent studies are showing that this trend is continuing (Poe-Yamagata & Butts, 1996). While a 3% increase may not sound like a concerning figure, this equates to approximately 17,000 more young women who are committing crime in a ten-year period, and few have any leads as to why. What is known, however, is that a large majority of young women entering the youth justice system have experienced some kind abuse in their homes, are involved in drug use, have one or more mental illnesses, or some combination of the above (Haringsma, 2012). This increase of young women offending is prompting a conversation as to what should be done in remedy.

An important topic in criminology is whether or not prison sanctions effectively decrease recidivism among those who serve prison sentences, and research is showing that prison is failing to do so (Smith, Goggin, & Gendreau, 2002). Nonetheless, one argument is that the Canadian Youth Criminal Justice Act should be revised once more to impose harsher sanctions for youth. The Youth Criminal Justice Act is the body of law that applies to Canada's youth who are between the ages of 12 and 18, and has been revised in the past to implement such changes (Department of Justice, 2017). This article will discuss alternatives to increasing the severity of sentences for young girls, such as non-profit after school programming, as well as the disadvantages of harmful and ineffective prison sentences. It will be argued that increasing the severity of sanctions will not only be unjust to young women, but that they will contribute to the issue of female youth crime.

Discussion

Adverse backgrounds

Children coming from dysfunctional, abusive home and family environments have been found to develop maladaptive coping strategies in order to survive their environment (Levenson, et al., 2017). Further, children with criminal histories have the highest rates of childhood abuse and dysfunctional families than the general population, which has been found to lead to mental health disorders, drug abuse and continued criminality in their adulthood (Levenson, et al., 2017). Youth in the criminal justice system have been consistently found to have higher rates of adversity and to have experienced prolonged, multi-formed trauma which puts them on the path towards a life of crime unless interventions are introduced to address said trauma (Levenson, et al., 2017). One model to address the aversity that young people are facing is trauma-informed care. Trauma-informed care is care that is aimed to help youth identify their unmet emotional needs in ways that are healthy and do not harm others (Levenson, et al., 2017). Trauma-informed care should be integrated into all forms of rehabilitation for youth, whether it be inside institutions or as a part of alternative sanctions. Additionally, staff working with youth who have traumatic pasts are encouraged to avoid excessive authoritarian interactions while modelling boundaries and effective use of communication to express feelings (Levenson, et al., 2017). Using trauma-informed care practices in prisons and similar environments can ensure that young women's traumatic pasts are being addressed and recognized as a part of their rehabilitation.

On the topic of girls in the youth criminal justice system, a study from the University of San Diego found that incarcerated girls were more likely to receive clinical diagnoses of major depression, post-traumatic stress disorder, separation anxiety, and disruptive disorders than their male counterparts (McCabe, Lansing, Garland, & Hough, 2002). Girls also reported significantly greater rates of physical, sexual, and emotional abuse and greater rates of physical neglect than boys (McCabe, et al., 2002). This suggests that many young women entering the criminal justice system are growing up in environments of great adversity. Therefore, it could be said that much of their criminal behaviour is a product of a number of sociological, psychological and economic disadvantages, rather than being inherently flawed individuals. In these cases, young women need positive resources to address the underlying issues that led to their criminality. Increasing the severity of sanctions for young women may only postpone additional acts of crime until they are released unless something more is done to address the reasons they are committing crime in the first place (Smith et al., 2002).

Alternative programming

The hardships young girls in the juvenile criminal justice system face are plenty and more apparent that those found among young male offenders. McCabe et al. found that "families of delinquent girls are often more dysfunctional than those of male delinquents, and are characterized by a high [frequency] of mother-daughter conflict" (2002). In cases such as these, a program such as the Big Sisters program, an alternative to severe sanctions, could be useful for young women who lack important relationships in their lives. Relationships, such as the between mother-daughter relationship, are vital, and weakness in that relationship may create more problems for young women. An addition of a positive female role model would be highly beneficial according to criminologist Travis Hirschi, creator of the Social Bond Theory. In said theory, Hirschi outlines the importance of our attachments, commitments, involvements and beliefs (Hirschi, 1969). According to Hirschi, a weakness in one or more of these bonds may result in delinquent behaviour (1969). By referencing Hirschi's theory alone, young women, as well as the communities they inhabit, could benefit greatly by introducing positive female role models who can continually promote prosocial behaviour.

In addition to programs such as the Big Sisters program and other similar after school activities, research has shown that alternative treatments to incarceration such a therapy and counselling for mental health issues may be beneficial to young women in the criminal justice system (Haringsma, 2012). Female youth have been shown to be more likely to be open to therapeutic interventions than their male counterparts, suggesting that this alternative could be both effective and desirable to young women (Haringsma, 2012). Because of the adversity young females in the youth criminal justice system face, programs that offer gender specific help have been proven to be greatly beneficial. Programs such as Working to Insure and Nurture Girls Success (WINGS), Reaffirming Young Sisters' Excellence (RYSE) and Holistic Enrichment for At-Risk Teens (HEART), have yielded extremely positive results. Some of these results include more protective factors and fewer risk factors upon leaving the programs, significant increases in school attendance, higher rates of girls completing their probation, and improved social, family, and relationship support (Zahn, Day, Mihalic, & Tickavsky, 2009). With the research done showing the various forms of abuse young female offenders suffer, in collaboration with the positive outcomes of alternative treatments for female youth, it could be said that increasing punishment for young women would be unjust.

Prisons

Not only are the benefits of alternative programs for young female offenders very apparent, so are the disadvantages of prison sentences for youth. It is becoming increasingly easy for youth to be sentenced as adults, therefore receiving longer prison sentences despite the fact that there is little evidence that suggests longer sentences decrease youth crime (Taylor, 1996; Smith, et al., 2002). When youth are sentenced to significant amounts of jail time, it further removes them from the protective factors that may better rehabilitate them to become more prosocial members of society. Protective factors can be defined as "characteristic[s] at the biological, psychological, family, or community… level that [are] associated with a lower likelihood of problem outcomes or that reduces the negative impact of a risk factor or problem" (Youth.gov, n.d.). In other words, protective factors aid youth in properly working through trauma they have experienced that made them at risk for becoming offenders in the first place. When sentenced to prison incarceration, young women are removed from their peers, family, school and any other potentially positive association that could rehabilitate them. Some may argue that it could be a youth's peers, family members, or lack thereof, that put them on a trajectory for committing crime in the first place. However, I argue that immediately resorting to incarceration for these youth would only lessen the possibility for reparation of those relationships, which could be highly influential in improving young women's long-term wellbeing.

In addition to being removed from their peers, family, and schools, female youth are being imprisoned in facilities that are furthering their likelihood to commit more crime. Due to overcrowding, youth are being faced with poor living conditions, increased health issues, and more youth-on-youth incidents as a result (Taylor, 1996). Furthermore, over 11,000 youth in prisons have engaged in over 17,000 incidents of suicidal behaviour while being imprisoned in juvenile facilities (Taylor, 1996). Youth prisons are lacking the resources for young women who need quality mental health professionals to aid in their rehabilitation while in the juvenile criminal justice system (Scott & Ruddell, 2011). Because of the lack of supportive programs and positive role models to aid in their recovery while in prison, detained youth are seeking relationships and engaging in gang activities that further their criminal activity (Scott & Ruddell, 2011). Female youth are often entering the criminal justice system under severe cases of adversity, which may include a lack of attachments, commitments, involvements and beliefs (Hirschi, 1969). Later research has supported Hirschi's theory by showing that the seeking of security and sense of belonging in gang membership is a consequence of having dysfunctional, abusive families, absent or uninvolved parents or attachments, as well as family disadvantage and poverty (Scott & Ruddell, 2011). To counter these deficits, or socialization voids, young women may turn to prison gangs to fulfil their need for affiliation, achievement, and social support (Carrasco, 1999; Scott & Ruddell, 2011). Due to the increase in popularity of female gangs, along with the increase of female youth crime, the likelihood of girls to join a gang is increasing (Moore & Hagedorn, 2001).

While there is limited research on the long-term consequences of gang membership, preliminary research suggests that a lack of positive role models for these girls, in combination with the risk factors associated with gang membership, such as low socioeconomic status and history of abuse, may lead to more crime (Moore & Hagedorn, 2001). Furthermore, it has been shown that any environment that groups high risk youth together in the absence of structured programs is associated with higher levels of criminal behaviour (Ross, Duckworth, Smith, Wyness, & Schoon, 2010). While prison itself could be considered a

structured program, the nature of prisons does not facilitate the kind of supportive environment that is required for programs to be effective. The combination of poor living conditions associated with prison life is currently putting young women at risk for committing more crime while harming their mental health in the process (Taylor, 1996).

One study has shown that more therapeutic approaches to at risk youth was more effective than methods of control or coercion (Ross, et al., 2010). The authors state that,

> *Evidence suggests that [programs] that mainly [focus] on deterrence or discipline can actually have the opposite effect and lead to an increase in offending behaviour. For example, [programs] that employ shock tactics, such as 'scared straight' programs, where young offenders are taken to maximum security prisons and told of the horrors and difficulties of life in prison by the inmates, have been linked with increased offending* (Ross et al., 2010).

This demonstrates the need for youth to feel supported rather than being attacked and criminalized. Feeling victimized by the criminal justice system may only push youth further toward anger and distrust towards a system that does not address their adverse backgrounds, ultimately resulting in increased recidivism upon their release (Smith, et al., 2002). Alternative sanctions and options such as trauma-informed care can give girls the opportunity to learn healthy coping mechanisms that do not result in criminal behaviour.

Cost benefits to alternative sentencing

In addition to the social justice-based arguments against increasing the severity of sanctions for youth, there are also significant economic benefits to keeping youth out of prisons. The incarceration of a woman in a federal prison can cost up to $250,000 a year for a single female inmate in Canada (Prisonjustice. ca, 2008). Not only is the cost alone staggering, it is upwards of two times the cost of the incarceration of a male inmate (Prisonjustice.ca, 2008). The needs of young women are plentiful, and despite the enormous cost of incarcerating them, they are still not receiving the required help. Programs such as Big Brothers and Big Sisters are volunteer-based, and many others work as non-profits that work to improve the lives of at risk youth and promote prosocial behaviour (Zahn, et al., 2009).

Research has shown that youth who participate actively in afterschool programs have significantly lower rates of juvenile crime which in itself is cost-beneficial (Healthy City, 2012). After school hours are known as the peak for youth crime, and since the implementation of after school programs in San Diego, juvenile arrests have decreased by 13.1%, a decrease which the San Diego Police Department credits to said programs (Healthy City, 2012). Furthermore, it was found that for every dollar spent on afterschool programs, a benefit of $2.50 was returned to the community in the form of costs avoided due to youth crime (Healthy City, 2012). Thus, not only are alternative options for female youth cost effective in terms of reducing prison costs, enrolling them in afterschool programs has the potential to give money back to the communities in which they live. While post-offence alternatives have been shown to be effective in preventing further criminal activity, a focus on preventative crime controlling measures could mean that young people do not have to come into contact with the youth criminal justice system at all. It has been estimated that a life-long offender or "career criminal" can cost the criminal justice system upwards of $1,000,000 (Smith, et al., 2002). Therefore, disrupting the trajectory of career criminality of even one young person has substantial financial benefits. While it cannot be assumed that all children coming from disadvantaged backgrounds are going to become offenders, it is a risk factor that cannot be ignored. And nevertheless, being able to provide programs for at risk youth would be beneficial whether they are on a trajectory of criminal activity or not.

Conclusions

The aforementioned arguments against harsh prison sentences should not be misconstrued to say that young offenders should not receive any kind of punishment for their crime. Simply giving girls a softer punishment for breaking the law will not reduce youth crime either. In a study titled, 'What Girls Need from the System,' female inmates were asked what the system could offer them that would have benefited them as young girls. One inmate replied as such:

> *… I think stricter discipline is … a necessity because if not, then you feel like, "well shit that was easy." . . . They fed me and they patted me on the head, and you know one year later, here I am back on the streets and if I do this again and get into trouble then I'm just [going to] go back to a place where they are [going to] feed me and I don't have to worry about somebody [beating] me there. I don't have to worry about somebody [molesting] me there, you know?* (Garcia & Lane, 2010).

This response illustrates the need for a balance between a safe and rehabilitative environment and an appropriate sanction that will provide consequences for their actions. In the same study, the three highest rated needs for girls in the system involved discipline and consequences, role models and mentors, and therapeutic treatments (Garcia & Lane, 2010). Research is showing that it is the combination of support and discipline that should be offered to young women in the criminal justice system. The hardship girls are facing going into the criminal justice system need to be addressed and repaired before sending them back to the communities they came from so that they can better maneuver and cope with their situations in healthier ways. It should be the responsibility of the prison industrial complex to address these social programming deficits within their institutions.

Research has shown that prison sentencing is increasing youth's involvement in criminal activity, is harmful to inmates' mental health, and expensive to maintain (Smith, et al., 2002; Taylor, 1996). Along with the beneficial behavioural and financial results of alternative rehabilitative programming, the need to overhaul the Youth Criminal Justice Act in favour of more severe sanctions is reduced significantly. Any revision to the Youth Criminal Justice Act should involve ways society can help youth move past the criminal justice system, not keep them there longer. The benefits to alternative sanctions are so promising that if government

funding was redirected to existing and new programs, society would be able to give young women coming out of the criminal justice system the opportunity enter their adulthood as prepared, prosocial individuals, or better yet, keep them from entering the system in the first place. Keeping female youth behind bars will not only take away their adolescence, but it could put them on the path to being kept in the criminal justice system forever.

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Processing faces in Alzheimer's disease patients: How a familiar face becomes unfamiliar

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Abstract: Alzheimer's disease, a progressive neurodegenerative disorder, is the most pervasive form of dementia worldwide. Impairment in face processing is a common trait of the disorder, causing a deficit not only in the processing of emotional expressions, but also causing a deficit in face recognition. Research into the causes of impaired face recognition in Alzheimer's disease patients has found several factors at play: Abnormal temporal lobe activation in response to familiar faces, a breakdown in holistic processing of faces due to changes in frontal lobe activation, and atrophy of areas of the brain implicated in theory of mind. These neural changes are evident long prior to any alterations of behavior. Due to the progressive nature of Alzheimer's disease, patients display increasing levels of impairment in face recognition over time. At the final stages of the disorder, patients lose all ability to recognize familiar faces, and most strikingly, lose the ability to self-recognize. Further research on face recognition in Alzheimer's disease may improve our knowledge both in neurotypical face recognition, as well as aid in discovering novel ways of helping patients cope with their symptoms.

INTRODUCTION

Alzheimer's disease is the most common form of dementia, a progressive neurodegenerative disorder which affects more than 35 million people worldwide (Wong, Gilmour, and Ramage-Morin, 2016). While a major factor in Alzheimer's disease is the loss of cognitive faculties, including memory, language, and planning, a particularly difficult aspect of the disease is the burden it places on interpersonal relationships (Pant, Mukhopadhyay, and Lakshmayya, 2014). One particular aspect of impairment in interpersonal relationships is the degradation of facial processing functions. Patients with Alzheimer's disease, in contrast to other forms of dementia, exhibit impairment in processing of emotions in facial expression, which may lead to loss of appropriate behavior in social settings (Bediou et al., 2009). Further, memory impairments stemming from the disorder cause difficulties in identity recognition of both new and familiar people (Hawley and Cherry, 2004). The loss of recognition of those familiar to us is especially intriguing. In later stages of the disease, patients may even lose the ability to recognize their own face, or the face of a spouse (Kurth, Moyse, Bahri, Salmon, and Bastin, 2015). Apart from causing emotional distress both for patients and caregivers, these symptoms often lead to social withdrawal, which exacerbates psychological symptoms further (Pant et al., 2014). Recent research has explored the mechanisms of facial processing in Alzheimer's disease, both in relation to learning new faces and recognizing familiar faces.

In this article, I will examine how Alzheimer's patients process faces as compared to the neurotypical population, discuss the current hypotheses that explain what mechanisms may cause a face recognition deficit in Alzheimer's disease, as well as the neural changes that may contribute to this deficit. I will also examine how the deterioration in facial processing occurs as the disease progresses, from preclinical stage Alzheimer's disease through to late-stage Alzheimer's disease patients. The purpose of this article is to examine how Alzheimer's disease affects the processing of both new and familiar faces, with the intent of understanding face- specific deficits in Alzheimer's disease.

The progressive nature of Alzheimer's disease is such that patients will continue to cognitively deteriorate until total loss of faculties, usually occurring at about ten years after initial diagnosis. As such, psychometric scales are used to qualitatively define a patient's stage of progression in the disease. The Global Deterioration Scale (GDS) may be used to assess primary degenerative dementia at seven stages of progression, where stage one represents no cognitive decline, and stage seven represents very severe cognitive decline (Reisberg, Ferris, de Leon, and Crook, 1982). In this article, I will refer to these seven stages as a quantifier for the stage of progression associated with a certain level of face recognition impairment.

Discussion

Face recognition in Alzheimer's disease

In the healthy brain, the processing of familiar faces has been examined extensively (Johnston and Edmonds, 2009). Face preferential regions, such as the fusiform face area, are important in facial processing, independent of whether the face is familiar or unfamiliar (Rossion, Schiltz, and Crommelinck, 2003). However, when processing familiar faces, there are two additional regions of the brain that are involved. Medial temporal lobe structures, including the hippocampus, amygdala, and the perirhinal cortex, along with inferior regions of the temporal cortex, respond abruptly when a person recognizes a face as familiar (Ramon, Vizioli, Liu-Shang, and Rossion, 2015). Interestingly, the medial temporal lobe is an area highly implicated in the pathology of Alzheimer's disease. Atrophy of the medial temporal lobe, in particular the hippocampus and the amygdala, has been well-documented as a biomarker for Alzheimer's disease (Visser, Verhey, Hofman, Scheltens, and Jolles, 2002). Atrophy of these regions in Alzheimer's disease patients may play a role in the breakdown of their face recognition processes as the disease progresses.

A remaining question is, what aspect of cognition are the face recognition deficits in Alzheimer's disease specifically attributed to? There has been speculation that the perceived deficit in facial recognition is actually due to a breakdown in semantic stages of recognition, as Alzheimer's patients commonly have trouble remembering names of familiar people (Werheid and Clare, 2007). Hodges, Salmon, and Butters (1993) looked at the processing of familiar faces

in Alzheimer's disorder by spontaneous and cued naming of famous faces. In a group of mildly impaired Alzheimer's patients, performance in identifying famous faces declined with increasing symptom severity. While patients were able to still spontaneously name famous people, they took longer to recognize and identify faces, and could not identify and name as many faces as the control group. Conditions of semantic cueing did not improve their naming abilities. The researchers concluded that Alzheimer's patients may have a breakdown in the pre-semantic stages of facial processing. As such, there must be a breakdown of facial processing in a stage prior to name retrieval.

An alternative hypothesis posits that Alzheimer's patients are impaired at the perceptual level of face processing, i.e., their ability to holistically process a face is impaired. Lavellée et al. (2016) investigated the processing of upright and inverted faces and cars in mildly impaired Alzheimer's patients. The inversion effect, in which it takes longer to process inverted faces versus upright faces, occurs because people normally process faces as an integrated whole, and are impaired in this ability when a face is inverted (Taubert, Apthorp, Aagten-Murphy, and Alais, 2011). Compared to controls, patients in the study showed a reduced inversion effect for faces, but not for cars. The researchers suggest that Alzheimer's disease patients are impaired in higher-level visual processing that requires holistic representation. Holistic processing of faces has been heavily implicated in the ability to recognize a face, such that the loss of holistic processing in Alzheimer's patients may be a direct link to the loss in recognition of familiar faces (Richler et al., 2011).

What then, is the neural basis for the loss of familiar face recognition? Certain prefrontal brain regions have been associated with familiarity recognition. This includes the bilateral superior frontal cortex, as well as the right middle orbital gyrus (Montaldi, Spencer, Roberts, and Mayes, 2006). Failure to activate these regions when exposed to familiar stimuli has been documented in patients with early stage Alzheimer's disease (Donix et al., 2013). There are also notable differences in cerebellar activity in patients with Alzheimer's disease, with a higher activation of the right cerebellum for unfamiliar stimuli in Alzheimer's patients as compared to controls. Alzheimer's patients have less activation in the medial frontal cortex, which has been associated with explicit access to contextual information surrounding a stimulus. In addition, Alzheimer's patients present with a reduced ability to recruit frontal brain regions during the perception of personally familiar stimuli (Li et al., 2015). Together, a reduction in access to contextual knowledge and episodes surrounding a familiar stimulus translates to reduced ability to recognize familiar stimuli in everyday life (Donix et al., 2013).

However, the loss of the ability to holistically process faces seems to be independent from the loss of processing other familiar stimuli. Another common feature in Alzheimer's patients is loss of memory for familiar locations (Pai and Jacobs, 2004). The mechanism for this ability has been found to be independent from face recognition, as impairment for scene recognition occurs earlier in the progression of the disease than does the impairment for face recognition (Cheng and Pai, 2010). Thus, there is not a generalized deficit in recognition per se, but rather separate mechanisms may be co-occurring to contribute to the loss of familiarity for different types of stimuli. Research indicates that Alzheimer's patients are better at recognizing objects such as houses than they are at recognizing faces (Kawagoe, Matsushita, Hashimoto, Ikeda, and Sekiyama, 2017). Further evidence for the specificity of facial processing impairment is indicated by deficits in emotion detection. As compared to mild cognitive impairment, patients with Alzheimer's disease are worse at detecting emotions in faces. In predementia stages of the disorder, there has been no documented impairment in emotion processing (Bediou et al., 2009). The deficit in emotional expression processing in Alzheimer's patients indicates that faces are more difficult to process in this population, and thus there is a specific deficit in holistic facial processing, rather than a general deficit in recognition of familiar stimuli.

Alzheimer's patients are not just impaired in recognizing the faces of familiar people. As the disease progresses, patients increasingly have difficulty with identifying a person, independent of face recognition processes. A final facet to explain the impairment of face recognition in Alzheimer's disease involves the ability to invoke theory of mind. Theory of mind involves the ability to understand that others have differing beliefs, and allows engagement in social and introspective behaviors (Dohnel et al., 2012). Areas of the brain implicated in theory of mind processing include prefrontal cortical areas; the medial prefrontal cortex has been implicated in conceptualizing mental states of others, while the superior frontal gyrus is implicated in self-related processes (Dohnel et al., 2012; Goldberg, Harel, and Malach, 2006). Theory of mind has been posited to be associated with face recognition processes. Impairment of this ability is well-documented in disorders such as schizophrenia and autism spectrum disorders, disorders which are also accompanied by impaired face recognition abilities (Irani et al., 2006). According to a review by Gobbini and Haxby (2007), theory of mind is necessary for familiarity recognition, as theory of mind regions of the brain are implicated in the non-visual cues of person recognition. These regions are hypothesized to act in conjunction with visual cues to invoke a mental representation of a familiar person.

In Alzheimer's disease patients, a genuine deficit in theory of mind has been documented at early stages of the disorder, and progresses as patient condition worsens (Moreau, Rausy, Viallet, and Champagne-Lavau, 2016). Furthermore, when Alzheimer's disease patients process familiar and self-face images, there is a negative correlation between connectivity in theory of mind implicated brain regions and ability to recognize faces. The current hypothesis for this phenomenon is that a decrease in the segregation of implicated neural networks leads to an increase in interference (Kurth et al., 2015). This implies that the medial prefrontal cortex and the superior frontal gyrus, regions involved in theory of mind, are implicated in the processing of familiar faces, and could explain the connection between worsened performance and unusual connectivity of these brain regions seen in Alzheimer's disease patients. This, taken with evidence from non-Alzheimer's research, implied that theory of mind plays a role in the loss of familiarity recognition in Alzheim-

er's disease. Thus, a reduced ability to invoke theory of mind in Alzheimer's patients, causing a deficit in understanding the minds of others, likely plays an indirect role in their impairment in familiar face recognition.

The time course of familiar face recognition in Alzheimer's disease

As Alzheimer's disease is neurodegenerative, it is important to examine how deficits in face recognition manifest throughout the course of the pathology. Genetic causes have been implicated in the pathology of Alzheimer's, with the discovery of autosomal-dominant Alzheimer's disease mutations. There is emerging evidence that for carriers of these mutations, dysfunction of neural circuits involved in memory occur prior to behavioral changes associated with diagnosis. In an fMRI study, carriers were shown to have abnormal activation in recognition tasks of face processing. Specifically, less activation was found in bilateral parietal regions of the brains of the subjects (Norton, Baena, Pulsifier, Lopera, and Quiroz, 2016). It is evident therefore that neural changes are taking place during the preclinical stages of the disease. In these preclinical stages, patients are still able to compensate for these neural changes and maintain normal cognitive abilities.

Eventually, neural changes overtake the brain's ability to compensate, and cognitive decline begins. Once behavioral changes are evident in the progression of Alzheimer's disease, face recognition will deteriorate in a more or less linear manner. In the mild cognitive impairment stage of Alzheimer's disease, there is evidence that patients are still able to identify familiar faces at the same rate as healthy individuals (Hodges et al., 1993). The major difference is length of time for recognition to occur; patients need more time to recognize a familiar face, and have more trouble identifying familiar faces by name (Hodges et al., 1993). So, while at the earlier stages of Alzheimer's disease patients will still be able to recognize familiar people, it is more difficult and time-consuming.

Patients with mild cognitive impairment (GDS stages 2 and 3) due to Alzheimer's disease will also not have difficulty recognizing recent photographs of themselves, which is a deficit that appears as the disease progresses. With moderate cognitive impairment (GDS stages 4 and 5), patients become better at recognizing more dated photographs of both themselves and their spouses in comparison to more recent images. Moderately impaired patients will also perform worse both on time taken to recognize familiar faces and on rate of recognition (Kurth et al., 2015). This indicates that with disease progression, patients are worse at recognizing familiar faces in general, and their mental representations of themselves and familiar people are likely to be temporally inaccurate.

Despite a decline in the ability to recognize familiar faces, there is evidence that Alzheimer's patients are still able to acquire representations of faces in the earlier to intermediate stages of the disorder. In a study by Hawley and Cherry (2004), patients with moderate Alzheimer's (GDS stage 4 and 5) were able to learn face-name recognition. Patients were trained to learn faces and names based on pictures, and were subsequently tested both in picture conditions and on live person transfer abilities, i.e., recognizing the people from the images in real life. Improvements were displayed over a two-week period, and maintenance of learned information was displayed. Thus, the ability to acquire familiarity of a face is still preserved at some level at these stages, and is displayed at a functional, real-world level. However, it is unclear from this study at what stage the ability to learn or recognize faces is lost, and whether it is consistent across Alzheimer's patients.

In the final and most severe stages of Alzheimer's disease (GDS Stage 6 and 7), patients have often lost all ability to recognize familiar faces and, most notably, can no longer recognize their own faces. Biringer and Anderson (1992) tested self-recognition in Alzheimer's patients in stages 5, 6, and 7 on the GDS scale, by presenting the patients with a mirror after marking their foreheads with paint. At stages 6 and 7, there was no response to the mark on the forehead, while the ability to self-recognize was still intact in GDS stage 5 patients. This provides evidence that patients at the final stages of the disease have lost all concept of the self and theory of mind. Without a concept of the self, the ability to recognize one's own face is lost, as well as the recognition of loved ones.

Conclusion

In conclusion, there are several neural processes implicated in the graded impairment of face recognition throughout the progression of Alzheimer's disease. The breakdown in face recognition is pre-semantic, meaning patients are not just impaired in ability to name familiar people, but are truly losing the ability to recognize the faces themselves. There is a loss of the ability to holistically process faces, and is a specific deficit for faces rather than a generalized deficit in the ability to recognize. Theory of mind brain regions are implicated in familiarity recognition, and deficits in theory of mind in Alzheimer's patients further impairs face recognition. Although there is no clear, unified answer for the deficit in face recognition exhibited by Alzheimer's patients, it may be due to a combination of the deterioration of theory of mind and holistic face processing abilities. Finally, the neurodegenerative nature of the disease is such that as the disease progresses, patients become increasingly impaired in their ability to recognize faces. Changes are evident in the connectivity of face recognition neural networks in Alzheimer autosomal dominant mutation carriers long prior to any observable behavioral effects of face recognition loss. The disease eventually progresses to the point that patients often have no recognition of their own face at the final stages in the pathology.

Understanding the deficits in face recognition in Alzheimer's disease patients both on a behavioral and neural basis may allow us to further our understanding of how familiar faces are processed in healthy patients. Furthermore, as research progresses, this may lead to a more complete understanding of the mechanisms behind the pathology and, consequently, novel ways to alleviate the social burdens placed on Alzheimer's patients and their caregivers due to the loss of face recognition.

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Soundproofing: the diminishing effect of media on sound intensity and resonance modes

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Abstract: The aim of the present experiment was to study the transmission of sound through a building by means of replicating a small-scale model of a floor and ceiling apparatus. Therefore, the relationship between input sine wave frequency and sound intensity through a closed apparatus was analyzed. The sound absorbance of various sound insulating materials was compared, and resonance properties of the apparatus was also considered. Sound intensity trends were investigated for frequencies within the human hearing range (up to the order of magnitude of 10,000 Hz), and different soundproofing material types (porous absorbers and resonators) were compared. It appears that the input sound wavelength (relative to the container size), as well as sound absorption coefficient were both major factors in transmitted sound's intensity. Porous absorbers were found to be the most robust material type at both resonance and non-resonance modes, and the optimal soundproofing material was the stone wool insulator (Material 2).

Introduction

Excessive noise is a common hurdle encountered in the field of building design, whether it be for office-spaces or apartment complexes. Sound insulators are materials that are frequently used to absorb, dissipate, or reflect sound waves as it moves through a medium (Hawkings, 2014), and so the implementation of soundproofing in buildings is of practical use. The purpose of this experiment was to provide a comprehensive study of sound transmission through an apparatus (of varying material type) at different input frequencies. A wooden container was designed with the purpose of modelling the structure that commonly separates the floor and ceiling in most buildings. Four different materials were individually compared against a control group, where no sound barrier was used. Materials 1 and 2 are both a type of insulator called porous absorbers, with Material 1 being a more slightly more inflexible variety of porous absorber. Like resonators, porous absorbers allow air to flow into a cellular structure where sound energy is converted to heat (Hawkings, 2014). Materials 3 and 4 are both a type of sound insulator called resonators, which act by trapping air in a chamber, either by the grooves in Material 3 or the negative space in Material 4, which compresses the sound wave to absorb energy (Hawkings, 2014). The key difference is that resonators trap air in long chambers, such as in a Helmholtz resonator, while porous absorbers have multiple small cavities in which to make the conversion. Furthermore, porous absorbers are much more pliable than resonators, which tend to be stiff, inflexible, and more capable of "resonating" with the incoming sound wave.

Methods

The ability of the different sound insulators to prevent the transmission of sound was tested at a range of frequencies. Pure sine waves with frequencies ranging from 300 Hz to 5,750 3 Hz were generated by a speaker connected to a computer, as shown in Figure 1. Three commercial sound insulators (Materials 1, 2, and 3) as well as a sheet of drywall (Material 4) were individually compared against a control group, which consisted of a trial that lacked any sound barrier. The sound intensity was measured for each respective material at 50 Hz intervals from 300 Hz to 1000 Hz, 100 Hz intervals from 1,000 Hz to 2,000 Hz, and 250 Hz intervals from 2,000 Hz to 5,750 Hz. White noise was also used to qualitatively observe the sound intensity behaviour of each material at frequencies greater than 5,750 Hz. Uncertainties were determined by taking ten measurements each at 500 Hz, 2,000 Hz, and 4,500 Hz, and calculating the standard deviation of those values. The relative uncertainties were then calculated and extrapolated to other measurements.

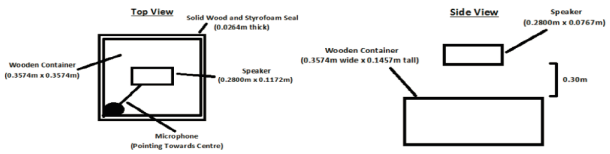

Figure 1: Design of experimental apparatus: the soundproofing material fits on top of a receded indent on top of the wooden container, and fixed between two layers of plywood and above one layer of drywall to simulate a traditional construction set-up; the microphone was suspended in the centre of the container

Results

As shown in Figure 2, the sound intensity for each material was recorded for specific input sound frequencies. The sound intensity difference between each trial and the control group can be interpreted as the magnitude of sound blocked by the material, which will subsequently be referred to as sound reduction. From 300 Hz to approximately 2,000 Hz, it appears the magnitude of sound reduction for each trial decreases. From approximately 2,000 Hz to 6,000 Hz, the magnitude of sound reduction appears to stay relatively constant. The standard deviation was calculated to be 1.07 Hz at 500 Hz, 2.20 Hz at 2000 Hz, and 0.77 Hz at 4500 Hz. (bottom) compared against the control (n = 40). White noise graphs (Figure 5) were created to validate the sound intensity measurements in Figure 2, as well as to gain a broader perspective of sound intensity trends at higher frequencies. White noise consists of generating a wide range of frequencies at equal intensity, and so the measured sound intensity is what sound remains after being transmitted through the soundproofing material. The sound intensity is relatively constant for all frequencies in the control group. Conversely, each soundproofing material appears to allow for significantly less sound transmission at frequencies on

the order of magnitude of 10,000 Hz, when compared with the control.

In Figure 4, it is also apparent that there is a fluctuation in sound reduction as a function of input frequency, thereby creating 'local minimums' and 'local maximums' in the plotted graph. By separating the material types in Figure 2 (porous absorbers versus resonators), it is apparent that there is a material dependency on the magnitude of intensity difference between local extrema. Materials 3 and 4 (resonators) appear to fluctuate more over the frequency range, while the intensity of Materials 1 and 2 (porous absorbers) varies less. Additionally, all materials in Figure 4 appear to arrive at regularly occurring local minimums at intervals of roughly 500 Hz.

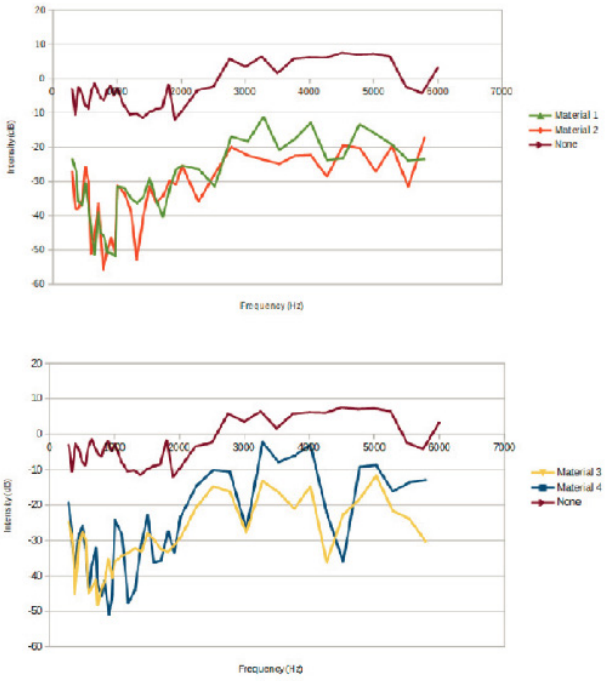

Figure 2: Sound intensity measurements (dB) of different frequency waves (Hz) propagated through porous insulators (top) and resonators (bottom) compared against the control (n = 40)

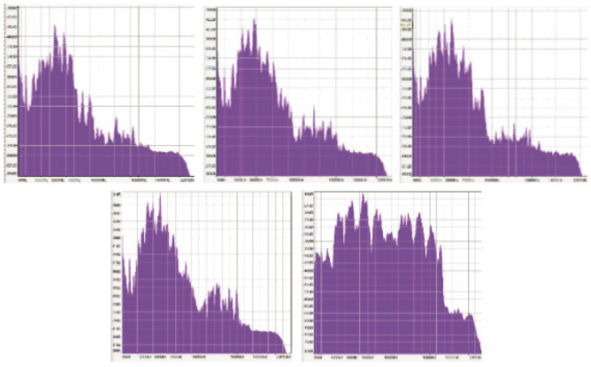

Figure 3: Intensity graphs of white noise propagated through various media; from top left to bottom right, the materials are Material 2, Material 1, Material 3, Material 4, and the control ('lidless') trial; frequency is plotted on the x-axis, in s-1, and intensity is plotted on the y-axis, in decibels; intensity not to scale

Discussion

The trends in overall sound reduction (Figure 2) can be explained by two separate factors: the wavelength of the input sound (relative to the size of the apparatus), and sound dampening by the material itself. At low frequencies, the wavelength of the sound is much longer than the size of the apparatus, and so it should interact with it less, as dictated by Huygens' principle (Encyclopaedia Britannica, 1998). During the experimental trials, a portion of the waves were likely not absorbed by the apparatus, and so did not translate into the 2D sound waves for the microphone to detect. Therefore, a higher proportion of low-frequency sound waves would have been detected by the microphone in open air for the control trial, compared with those that have a material covering the apparatus.

The addition of a soundproofing material requires that another major factor be taken into consideration. The sound absorption coefficient of each respective material, as described by Hawkins (2014), dictates that a material absorbs a certain percentage of the total energy of the sound wave Hawkins (2014). This defined fraction of energy should equate to a greater overall magnitude of absorption for high frequency waves, as the total energy of a wave is proportional to frequency.

Therefore, high frequency sound waves have a decreased chance of being reflected from the closed container (as dictated by its wavelength relative to the container), but will have a greater total magnitude of energy absorbed by a material (as dictated by the sound absorption coefficient). It appears that the high reduction of sound for materials at the low frequency range (from 300 Hz to approximately 2,000 Hz) can be explained by the relative wavelengths of the input sound, and container size. However, for the higher frequency range (approximately 2,000 Hz to 6,000 Hz), more wave energy can be transmitted into the container, but a greater magnitude of wave energy is also absorbed by the material – thus leading to a relatively constant reduction in sound. Finally, as confirmed by the white noise graphs in Figure 3, the sound reduction further increases for frequencies on the order of magnitude of 10,000 Hz, as the material absorbs an increased total amount of sound, and thus appears to be the dominant factor at this frequency range. It appears that the magnitude of reduced sound fluctuates as a function of input frequency, and local minimums are found at regular intervals. The fluctuation of sound reduction may indicate the presence of resonance modes, which can be supported through calculation as standing waves in a fixed system have frequencies of:

$$f = \frac{mv}{2L}$$

In the experimental conditions (dry air at 22oC), the speed of sound is 344.82m/s (Georgia State University, 2000), and so the fundamental frequency should theoretically exist at 520.88 Hz, with resonance modes existing at integer multiples of this value. Therefore, the fluctuation of sound reduction is likely due to resonance modes created by the geometry of the container itself.

The sound reduction graph appears to have local mini-

mums that exist approximately every 500 Hz. Additionally, it appears that the magnitude of reduction difference between resonance and non-resonance modes is correlated to the material type. As shown in Figure 2, this reduction difference is minimized for absorbers (Materials 1 and 2), and maximized for resonators (Materials 3 and 4).

The difference in how each material interacts with resonance modes can be attributed to the structural differences in material type. When resonators interact with sound waves, the rigid material bends, thereby causing an oscillation which propagates waves equal to the input frequency (Hawkings, 2014). If the apparatus resonates with a wave that exists at an integer multiple of the fundamental frequency, then it will constructively interfere with the standing waves created by the geometry of the apparatus. If not, then the two waves would destructively interfere. Therefore, the differences between in-phase and out-of-phase waves are highly apparent with resonators. As can be observed in Figure 4, the sound reduced is frequently minimal at what appears to be resonance modes of the container.

Conversely, porous absorbers are more flexible in nature and hence more likely to change shape when sound waves propagate through it. As sound waves travel through the material, longitudinal waves press the absorber towards the lid of the container. Then, as the wave travels out of the absorber, it causes the material to decompress. The cyclical action of compression and expansion would cause a component of the oscillation to be in the horizontal direction, therefore redirecting sound waves away from the container. The deflected energy of the sound waves would therefore be lost, regardless of whether the frequency is at a resonance mode of the container not. As more energy is lost due to horizontal deflection (relative to the resonator material type), the sound reduction difference of resonance and non-resonance modes would be less distinct. This supports the findings in Figure 2, where the porous absorbers reduce sound much more consistently than the resonators.

Conclusion

The fluctuation of sound intensity as a function of frequency appeared to be due to the effect of resonance modes created within the apparatus. Porous insulators were found to be more effective than resonators at minimizing the sound reduction fluctuation between resonance and non-resonance modes. The increased reduction of sound at low frequencies may be due to the input wavelength being longer than the container, thereby preventing it from being transmitted through it. Meanwhile, the increased reduction at high frequencies is likely due to the absorption by the material itself, as defined by the sound absorption coefficient. The optimal sound insulator was the stone wool insulator (Material 2), due to its capabilities at non-resonance modes (due to its material type), and overall superior sound absorption relative to Material 1. Future studies may include building a larger apparatus in order to better extrapolate results to real-life structures.

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