Homelessness and drug misuse in developing countries: A mathematical approach

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ABSTRACT

Homelessness and drug-misuse are known to exist like siamese twins. We present a model to capture the dynamics in the growth in the number of homeless (street kids and street adults) and drug misusers. The reproduction numbers of the model are determined and analyzed. Results from this study suggests that adult peer pressure plays a more significant role in the growth of drug-misuse and the number of street kids. This result suggests that in resource constrained settings intervention strategies should be tailor made to target adults whose behaviour influence others to misuse drugs and abuse children. Furthermore, numerical simulations show that homelessness and drug-misuse positively enhances, the growth of each other. Thus, to effectively control these two social problems require strategies targeting both of them.

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1. Introduction

Street kids are visible throughout the world in developed and developing countries [1,14,25]. Street kids is a term for children experiencing homelessness who primarily reside on the streets of a city. The most common definition of a street child or youth is "any girl or boy who has not reached adulthood, for whom the street (in the broadest sense of the word, including unoccupied dwellings, wasteland, etc.) has become her or his habitual abode and/or sources of livelihood, and who is inadequately protected, supervised or directed by responsible adults" [18]. The majority of street kids are actually street boys [1] and this has also been noted in Africa. In Zimbabwe, 95% of the 520 street kids interviewed were boys [18]. Homelessness also accounts for some people (adults and children) to live on the streets [8]. However, in Africa homeless children account for a minority of African street children. In a sample of 520 Zimbabwean street children, 15% were homeless street children [18]. In Zambia, only 2% of street children interviewed were homeless [23]. As of 2006, there about 12000 street kids in Zimbabwe with about 5000 of them living in Harare. Given the economic difficulties Zimbabwe experienced around 2008, the number of street kids may have increased greatly as many fled homes into the streets to scavenge for food.

The main factors leading to the growth in the number of street kids are economic (include extreme poverty, hunger, poor economy and unemployment) and abuse by guardians (mostly not biological parents including step parents) or neglect by parents [7]. Information from broader studies, court cases and press reports suggest that step children may be particularly vulnerable to physical, sexual, economic and emotional abuse as well as neglect [9,10]. Half of the street kids in Zimbabwe are orphans (9% maternal orphans, 25% paternal orphans and 17% double orphans) [16]. The majority of double orphans (56%) and maternal orphans (58%) lived in the streets most of the time [16]. In Zimbabwe HIV/ AIDS is a potential cause of poverty and increase in the number of orphans and street kids. However, there is no information to directly link AIDS and street kids [16]. Drug/ alcohol misuse is also known to be both a cause and a result of homelessness [8,11,19]. About

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80% of homeless people start using one new drug since becoming homeless [12]. Homeless people experience higher incidences of suicide (9 times more likely) and deaths as a result of traffic accidents (3 times more likely), infections (twice likely), falls (over 4 times) than the general population [20]. Children on the streets for reasons related to poverty are easier to reform as once their basic needs are met, their problems are over.

In Zimbabwe in the past street kids used to be removed from the streets to places of safety (probation homes or children's homes) through the social welfare department [14]. On the face of it, this was a noble idea but had inadeaquate facilities for the children [7]. Most children see probation homes not as safe places as they have inadequate facilities for them and are likely to escape back into the streets. Epidemiological contact models has also been applied to study the dynamics of social and behavioral processes [2–5,13,17,21]. Despite, the fact the drug-misuse is known to be prevalent among street kids, these two social problems have never been jointly analysed from mathematical persipective making this study possibly the first to do so.

The rest of the manuscript is presented as follows. In Section 2, the model is presented and analysed, Section 3 presents numerical simulations and finally a discussion is presented.

2. Model description

The model subdivides the population based on where they live, work and drug misuse. The population is divided into the following classes: susceptible children (these are children who not yet street kids and/ or drug-misusers) $S_c(t)$, street kids $I_{c_1}(t)$, drug misusing kids not street kids $I_{c_2}(t)$, drug misusing street kids $I_{c_{12}}(t)$, susceptible adults $S_a(t)$, adults who live in the streets and/ or abuse children under their care $I_{a_1}(t)$, drug misusing adults who are not child abusers $I_{a_2}(t)$ and drug misusing adults who live in the streets and/ or abuse children $I_{a_{12}}(t)$. Individuals in all sub-classes experience natural death at a constant rate μ. The total human population is given by $N(t) = N_c(t) + N_a(t)$, where

$$N_c(t) = S_c(t) + I_{c_1}(t) + I_{c_2}(t) + I_{c_{12}}(t) \quad \text{and} \quad N_a(t) = S_a(t) + I_{a_1}(t) + I_{a_2}(t) + I_{a_{12}}(t),$$

with $N_a(t)$ and $N_c(t)$ being the total number of adults and children, respectively. Susceptible children are recruited through birth at a rate Λ. Following excessive abuse at the hands of their guardians/ parents (mostly step parents), susceptible children $S_c(t)$ and drug misusing kids not yet street kids $I_{a_2}(t)$ flee their homes and move into streets at rates $\lambda_a(t)$ and $\sigma_a \lambda_a(t)$, respectively into the following respective street classes $I_{c_1}(t)$ and $I_{c_{12}}(t)$. The enhancement factor $\sigma_a \geqslant 1$ signifies the increased chances a drug misusing kid has of fleeing home when abused by a guardian. Here,

$$\lambda_a(t) = \frac{\beta_a[I_{a_1}(t) + \theta_a I_{a_{12}}(t)]}{N_a(t)}, \tag{1}$$

where β_a is the product of the probability of becoming a street kid per abuse and the number of times one is abused, $\theta_a \geqslant 1$ accounts for increased chances for being abused for those staying with abusing guardians who misuse drugs. In this manuscript abuse shall mean physical abuse, physical neglect (failure to provide basic necessities of life for the kids possibly as a result of poverty), sexual abuse or emotional abuse. Street kids experience further death due to the difficulties they face daily (eating contaminated food from the bins, lack of medical care when sick and bad weather) at a rate ν_s which is proportional to the number of street kids. Some of the drug-misusing street kids influence other children (peer pressure) in $S_c(t)$ and $I_{c_2}(t)$-classes to flee homes into the streets (become street kids) where they can take on drugs/ alcohol without adult supervision at rate $\lambda_{c_p}(t)$ and $\sigma_{c_p}\lambda_{c_p}(t)$ ($\sigma_{c_p} \geqslant 1$ accounting chances a drug misusing kid has of fleeing home into the streets due to peer influence), respectively into the following classes respective classes $I_{c_1}(t)$ and $I_{c_{12}}(t)$. The force of 'influence' $\lambda_{c_p}(t)$ is given by

$$\lambda_{c_p}(t) = \frac{\beta_{c_p}[I_{c_1}(t) + \theta_p I_{c_{12}}(t)]}{N_c(t)}, \tag{2}$$

where β_{c_p} is the product of the probability of becoming a street kid as a result of contact with street kids and the number of times one spends time with street kids, $\theta_p \geqslant 1$ accounts for increased chances for being a street kid for those staying in close contacts with drug misusing street kids.

Children in $S_c(t)$ and $I_{c_1}(t)$-classes acquire drug misusing habits at rates λ_{c_d} and $\delta_c \lambda_{c_d}$ into $I_{c_2}(t)$ and $I_{c_{12}}(t)$-classes, respectively, $\delta_c \geqslant 1$ accounts for increased chances of a street kid has of becoming a drug misuser. The force of peer influence $\lambda_{c_d}(t)$ is given by

$$\lambda_{c_d}(t) = \frac{\beta_{c_d}[I_{c_2}(t) + \theta_{c_d} I_{c_{12}}(t)]}{N_c(t)}, \tag{3}$$

where β_{c_d} is the product of the probability of a kid becoming a drug misuser as a result of contact with other kids who are drug misusers kids and the number of times one spends time with drug misusing kids; $\theta_{c_d} \geqslant 1$ accounts for increased chances for being a drug misuser for those staying in close contacts with drug misusing street kids. Drug misusing kids experience drug related illnesses like (liver cirrhosis, pancreatitis, lung cancer, heart failure, etc.) and die as a result of these illnesses at a rate ν_d.