

**Artisanal mining and the determinants of health: a global literature  
review**

by

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## **ABSTRACT**

Globally, an estimated 13 million people are directly involved in artisanal and small-scale mining activities and an additional 80 to 100 million people depend directly or indirectly on the associated activities. The objective of this paper is to explore how ASM is intertwined with the determinants of health as outlined by the Public Health Agency of Canada, and to address related policy issues. A systematic review of the literature was conducted through Google Scholar. A trend that emerged throughout the literature was that ASM has significant impact on many aspects of health and well-being of the miners, communities and countries. However, because these activities are often illegal or unmonitored, mitigation of adverse impacts is illegal. Increasingly scholars argue that these activities need to be approached as a development problem, where the central goals should be to devise and support appropriate and sustainable means of artisanal mining and poverty alleviation.

**Keywords:** artisanal and small-scale mining; determinants of health; literature review

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## INTRODUCTION

Globally, artisanal and small-scale mining (ASM) activities are as important as large-scale mining activities when considering the direct and indirect impacts it has on the determinants of health as outlined by the Public Health Agency of Canada (*Appendix 1*). In terms of employment, ASM activities are widespread; an estimated 13 million people worldwide are working directly in small-scale mines, largely in developing countries (Hentschel et al., 2002; Quiroga, 2002). In some developing countries, the production of ASM may even equal or exceed the production of large-scale mines (Hentschel et al., 2002). Further, approximately 80 to 100 million people globally depend directly or indirectly on some form of informal mineral resource extraction as a means of earning a living (Gunson and Veiga, 2004). Artisanal and small-scale miners extract a wide variety of deposits, ranging from gold, gemstones and other valuable deposits to bulk commodities including limestone and coal. The estimates of the number of people directly or indirectly involved in ASM can vary depending on the types of deposits that are included in the approximation (Lahiri-Dutt, 2008).

Participation in ASM does not go unnoticed, yet no common, internationally recognized definition surrounding artisanal and small-scale mining currently exists (Quiroga, 2002). A significant factor contributing to the absence of a unified definition is the specificity of each individual place, country and the context in which ASM occurs (Hentschel et al., 2003). Hentschel et al. (2003), however, have characterized ASM by a number of conditions (*Appendix 2*), which broadly defines ASM as an organization of people, whether it be individuals, groups, families or cooperatives, who mine informally or illegally in the sector with little to no mechanized equipment (Hentschel et al., 2002).

Synonyms of artisanal and small-scale mining can include “ninja” mining (Mongolia), galamsey miners (Ghana), hand mining, placer mining or informal mining. The common theme is that the majority of this type of mining is done illegally or with minimal regulation (Hentschel et al., 2002).

For many people participating in ASM in developing countries, the various activities associated with ASM are an extension of their traditional ways of life and culture. However, by in large ASM is poverty driven and provides a means of employment and a way of obtaining an income for the individual and/or their families and communities (Lahiri-Dutt, 2008). Women and children are often involved in artisanal and small-scale mining operations, from the extraction to the selling of the commodities to the organization of the mining areas (Heemskerk, 2003). Homes are frequently the workplace in artisanal mining, for example when separating gold from ore (Kuramoto, 2001). Due to the unregulated nature of this sector, participation in ASM involves many health risks and hazards, environmental degradation and detrimental effects on education, personal health practices and healthy child development (Keita, 2001; Hilson et al., 2007; Lahiri-Dutt, 2008).

This paper aims to provide a systematic review of the literature surrounding global artisanal and small-scale mining and how it is intertwined with the twelve determinants of health as outlined by the Public Health Agency of Canada (*Appendix 1*) (PHAC, 2003). The approach of the paper is to present the broad, major themes within the literature related to ASM, versus a detailed analysis of how specific findings in each retrieved article lines up against the determinants of health. Although not all of the literature is referenced within the body of the paper, it is organized systematically in the Appendices,



and each article is marked appropriately with the corresponding determinants of health noted.

## **METHODS**

A problem often cited by authors when researching ASM is the inadequate quantity of literature and data on this subject. There is a limited amount of creditable data and literature surrounding the topic of ASM due to: the small sample size of the data, no clear definition that is internationally recognized, poor record keeping because of the informal and unofficial nature of the sector and fear of reporting because of government hindrance (Lahiri-Dutt, 2008). To combat this issue, a variety of search terms were used to encompass a broad spectrum of ASM and how it is interconnected with the determinants of health.

### ***Search terms and database***

The list of search terms was composed with the help of faculty members from Simon Fraser University (SFU), the Canadian Coalition for Global Health Research (CCGHR) Mongolia team, the Department of Health- Health Promotion division in Ulaanbaatar, Mongolia and a second SFU graduate student. There were four main ‘roots’ of search terms used: artisanal mining, small-scale mining, informal mining and ninja mining. For each of the four search terms, the root as an entity was each used as an individual search term. Subsequently, two other searches were performed with the root search terms plus the addition of: 1) social determinants and 2) health. ‘Small scale mining in Mongolia’ was used as a separate search term, because Mongolia was originally going to be used as a case study for artisanal and small-scale mining. But, when the literature review was started it was decided that the search should be expanded

globally, as many developing countries have an informal sector of ASM. Additionally, ‘artisanal and small scale mining’ was also used as a separate search term, because the body of literature often uses ASM as a broad classification for this sector. Hand mining was originally included in the list of search terms, however, it was later removed because it produced too many results for ‘data mining’ and ‘hand injuries’ that were not related to artisanal and small-scale mining. In total, 14 search terms were used for this systematic literature review; a chart displays the number of files produced for each search term as well as the number of relevant files (*Appendix 3*). The database used to conduct the literature search was Google Scholar, from SFU’s library account. Google Scholar was used instead of other databases because it allowed for access to a broad range of articles, enhancing the likelihood that all twelve social determinants of health would be addressed.

### ***Systematic literature review tool***

The twelve determinants of health that were used are outlined by the Public Health Agency of Canada (*Appendix 1*) (PHAC, 2003). Each piece of literature, whether it was a journal article, book (electronic) or grey literature, was entered electronically into an SFU account created in RefWorks. RefWorks served as an online method to catalogue literature found in the searches. Once all the searches were complete, the literature entered into RefWorks was then put into a chart that included the twelve determinants of health, which are numbered along the heading of the chart (*Appendix 4*). A category of regulation/ policy (column 13 in *Appendix 4*) was added to the chart because regulations and policies and their direct and indirect relationship to ASM were a reoccurring theme throughout the literature. Each piece of literature was then reviewed to determine which of the determinants of health were referenced and how these related to ASM. A

subsequent ‘X’ was then placed under the appropriate category (*Appendix 4*). Deciding which of the determinants were referenced within the literature may be considered somewhat arbitrary and thus this methodology may be seen to have a subjective element; however, the *Underlying Premises and Evidence Table* from the Public Health Agency of Canada was used as a guide as to determine how each determinant influenced health (PHAC, 2003).

In the chart entitled *Systematic Literature Review Tool*, a total of 123 relevant articles were entered. All of these articles were first entered into RefWorks and then were entered into the chart (*Appendix 4*) using specific formatting that was agreed upon with the previously mentioned colleagues. A total of 14 search terms were used to find relevant articles related to ASM, but only 8 search terms were used when entering the articles into the Systematic Literature Review Tool. The principal reason that not all of the search terms were used when entering the articles was that the root search terms, for example ‘artisanal mining’, were used first when searching for articles and thus produced a greater number of relevant articles. Although the more specific search terms, such as ‘artisanal mining health’ did produce relevant files, all of relevant articles were already entered under the root search term. An exception to this was with the root search term ‘ninja mining’ and the more specific terms ‘ninja mining health’ and ‘ninja mining social determinants’, as all three search terms produced relevant articles that were not identified in the original search. This exception could be due to the fact that the root search term ‘ninja mining’ is already a specific search term, often used to describe ASM in Mongolia. Nonetheless, the broadest search term ‘artisanal and small scale mining’, produced the

most relevant articles, followed closely by the search term ‘artisanal mining’ and then ‘informal mining’ (*Appendix 3*).

## **RESULTS**

### **1. Biology and Genetic Endowment**

With respect to ASM, biology and genetic endowment in the literature often refers to human exposure to heavy metals associated with ASM and the biological markers used to indicate the level of exposure (Betancourt et al., 2005; Clemente et al., 2004).

Mercury amalgamation of gold is an extraction method that is still widespread throughout the ASM sector due to the inexpensive costs, while cyanidation of gold tends to be used for larger mining operations (Clemente et al., 2004). The removal of mercury is often through vaporization; consequently, mercury is released into the surrounding home and environment, having detrimental health effects on residents situated near the ASM sites. Hair and blood samples are taken to measure the bioaccumulation of mercury, which often occurs through the inhalation of mercury vapors, the ingestion of water and fish, and absorption through the skin (Betancourt et al., 2005; Counter et al., 2002; Clemente et al., 2004, Grandjean et al., 1999). In the majority of the literature with a biology and genetic endowment component, the communities where data was collected from were located near water sources, most commonly near rivers. Additionally, according to hair and blood analysis, the communities in which the majority of the residents drank river source water and ate the fish from the river had the greatest bioaccumulation of heavy metals (Betancourt et al., 2005; Clemente et al., 2004, Grandjean et al., 1999). Grandjean et al. (1999) examined the health effects on children, specifically the neuropsychological aspects, and found that maternal and child mercury concentrations were highly correlated,

and that high concentrations of mercury in children were sufficient to cause adverse effects on healthy brain development. The high correlation between maternal and child mercury concentrations and neurological damage can also be attributed to the high concentrations of mercury vapors in the home from the extraction method of separating gold from ore and soil (Spiegel and Veiga, 2005; Counter et al., 2002).

## **2. Culture**

There are many definitions of culture; the one used here will encompass a socio-cultural context of cultural backgrounds, dominant cultural values, beliefs and traditions. Applying this definition, culture clearly effects health by affecting particular behaviors related to ASM. ASM activities in some developing countries are viewed as an extension of traditional ways of life and culture for the people who are directly and indirectly participating (Lahiri-Dutt, 2008). Although ASM can be viewed as a continuation of culture and tradition, in many developing countries, where the majority of ASM occurs it is often categorized as illegal, informal mining (Fisher, 2007). This labeling, coupled with the lack of regulation and policy, has resulted in the marginalization and segregation of the people within the ASM community (Fisher, 2007). Women may be marginalized from ASM, because the ‘work force’ in various cultures, such as in Suriname, South America, tends to be dominated by males, and females are discouraged from engaging in mining activities (Heemskerk, 2000). It is important to note that within the literature, there is a lack of consensus in whether women are allowed and encouraged to work in small-scale mines, or they are discouraged from working in the mines with the males and are therefore marginalized (Deb et al., 2008; Heemskerk, 2000). However, in countries where dominant cultural beliefs are shifted towards the discouragement of women

participating in ASM, the internalization of such gender roles perpetuate the cultural restrictions that hinder the mobility of women and their opportunity to make an income (Heemskerk, 2000). Both marginalized groups, the artisanal and small-scale miners from the community and the women who are unable to participate in ASM, are at an increased health risk because they lack access to necessary health services and resources (Heemskerk, 2000). Lastly, culturally-valued, traditional lands are at an increased risk of becoming degraded by ASM, as it is very difficult to achieve protection or negotiations of land settlements, an effect that is irreversible in nature (McMahon et al., 1999).

### **3. Education**

Education includes both the education of the miners on safe practices of mining and the formal school education of miners and their families who directly and indirectly participate in ASM activities (Ayree et al., 2003). A tertiary theme of education in the literature surrounding ASM is educating the public and raising awareness about the impacts of ASM in order to initiate movements which place pressure on governments to take some form of action, whether that be the legalization of ASM or the greater regulation of ASM activities (Ayree et al., 2003). Ghana provides an example of what is being done by government in the informal sector of ASM where several educational initiatives for artisanal and small-scale miners have been initiated. Operators of informal mining activities are being educated about and advised of benefits of adopting sustainable mining and processing practices and how to improve environmental management through teaching proper reclamation and waste control (Ayree et al., 2003). Education provided to the miners also consists of safety training, book keeping and cost calculating initiatives, along with the abatement of mercury pollution (Hilson, 2006; Lahiri-Dutt, 2008; Ayree et

al., 2003). The main objectives of the education and training initiatives are to foster an attitude change among the miners in order to increase their accountability for following safe and sustainable mining practices and to address the environmental degradation that is caused by ASM (Ayree et al., 2003). However, there are examples where education initiatives fail to achieve the objectives of information dissemination to the miners, especially in the field of mercury abatement (Hilson, 2006).

Individuals and families who participate directly or indirectly in ASM typically live close to mining areas, and thus tend to be further from formal educational systems. Therefore it is difficult for miners and their families to access schooling, due to the distance and a lack of time, as mining duties require long, strenuous hours. Further, women and children are disproportionately limited in educational opportunities as they may begin participating in informal mining activities at a young age to help contribute to the family income (Lahiri-Dutt, 2008). The lack of education and schooling then leads to limited future opportunities; a cycle that perpetuates inequities for artisanal and small-scale miners (Lahiri-Dutt, 2008). Again, the boundaries are blurred regarding the effects of ASM on the determinants of health, since education has components of other determinants, such as gender and healthy child development.

#### **4. Employment/ Working Conditions**

The main themes for employment as a determinant of health found within the body of literature regarding ASM are the lack of employment opportunities in other sectors, unsafe working conditions and the increased health risks for people who work as small-scale miners. As previously mentioned, ASM is a poverty-driven activity, and frequently occurs in developing countries where there is a lack of employment opportunities

(Andrew, 2003). Displaced people living in developing countries who are unable to find employment elsewhere, often turn to artisanal and small-scale mining in rural and remote areas as a form of employment (Hilson and Banchirigah, 2009). Another reason that individuals turn to ASM is because of the seasonal nature of agriculture and the inability to rely solely on an income from it year round (Hilson and Banchirigah, 2009).

Regardless of who is working in the mines, the rapid increase in the ASM sector over the last decade can partially be attributed to a lack of employment opportunities in other sectors (Hilson and Banchirigah, 2009). To combat this growing problem, policymakers, including governments and donor organizations, believe that creating alternative employment opportunities will reduce the incidence and prevalence of ASM (Hilson and Banchirigah, 2009).

Unsafe and stressful working conditions are associated with a decline in one's health and well-being (PHAC, 2003). With respect to ASM and the lack of regulations surrounding the practice of informal mining, it has proven difficult to obtain accurate accident and occupational health statistics (Chakravorty, 2001). It is also not clear which type of mine – opencast (e.g. Iron Ore, Limestone, Manganese) or underground (e.g. Gold, Copper, Galena), is more dangerous for artisanal miners (Chakravorty, 2001). Although the literature is fairly inconclusive regarding accident rates, the poor employment and working conditions are irrefutable (Kibadi et al., 2008). Due to legality and regulation issues, artisanal miners often work for long hours with relatively little to no personal protective equipment, increasing the already high exposure to toxic heavy metals used in the extraction process (Deb et al., 2008; Kibadi et al., 2008; Keita, 2001). This combination is often exacerbated by poor nutrition, increasing the risks for poor



health outcomes (Keita, 2001). Further, it is common for artisanal and small-scale miners to do refining work within their homes (Kuramoto, 2001; Spiegel and Veiga, 2005). The practice of burning mercury to separate gold from soil and sediment is commonly done in the family homes of the gold miners and is often carried out by women and children (Kuramoto, 2001; Counter et al., 2002). As a result of this method, mercury vapors are released into the air of the home and are then inhaled. Consequently, mercury poisoning can occur when the mercury vapors diffuse into the blood, pass the blood-brain barrier and accumulate in the brain (Counter et al., 2002). When prenatal and early life exposures for children occur, there is often damage to the developing central nervous system, thus resulting in neurological damage (Counter et al., 2002).

Although the literature often emphasizes the negative aspects of ASM employment, some literature also identifies some of the positive benefits of ASM for communities. A large number of people often living in rural or remote communities earning low-incomes are employed in ASM. ASM not only provides a source of income for the miners and their families, but it also can provide revenue for the communities (Deb et al., 2008). The minerals extracted from artisanal and small-scale mines can be sold or exported at low costs, and thus can generate revenue for the community and the country (Deb et al., 2008).

## **5. Physical Environment**

Degradation of the physical environment and its impact on health is frequently mentioned in the literature as a global problem associated with ASM. Mercury and often cyanide contamination are the biggest and most concerning problems of ASM. These toxic chemicals, often used for amalgamating the deposits, are poorly handled and

discarded into the environment without adequate control of waste products (Hilson et al., 2007<sup>1</sup>; Kuramoto, 2001). Once the mercury is released freely into the environment, the airborne emissions and liquid runoff are transformed into a toxic compound called methylmercury (Hilson et al., 2007<sup>1</sup>). Methylmercury is an especially harmful toxin, as it has the ability to bioaccumulate in living matter found in the environment and animal tissue (Hilson et al., 2007<sup>1</sup>). Erosion and contamination of water sources are also significant problems that stem from ASM, especially in semi-tropical regions (Gunson and Jian, 2001; Kuramoto, 2001). Although there seems to be improvement in environmental regulation and land reclamation for larger mining operations, the same cannot be said for ASM (McMahon, 1999).

A body of literature based on case study analyses suggests that artisanal and small-scale mining needs to be regulated with more policy surrounding environmental concerns for there to be an improvement in the physical environment (Tarras-Wahlberg et al., 2000; McMahon, 1999). In the case of small-scale gold mining in Ghana, where ASM was legalized through the Small Scale Gold Mining Law passed in 1989, environmental protection policy still remains to be a priority on the agendas of government and policy makers (Hilson, 2002). In countries where ASM is not legalized, such as the small-scale gold mining carried out in southern Ecuador, the artisanal miners do not have the financial means nor the necessary information needed for environmental concerns to be a priority (Tarras-Wahlberg et al., 2000). In order to address both of the aforementioned scenarios, Hilson (2002) suggested that the following conditions must be in place in order to achieve environmental improvement. The conditions include the following: 1) financial and resource assistance provided to the artisanal miners and/or their governing

body, if applicable, 2) the creation and implementation of ASM tailored environmental management approaches and resources, 3) identification of deposits suitable for ASM to prevent further environmental degradation through excessive exploration, and 4) national involvement in an industrial mercury study with adequate reporting component to the abatement of mercury use for extraction of minerals (Hilson, 2002). In addition to these conditions, it is important to incorporate indigenous peoples as stakeholders in environmental discussions as they often have historical ties to the land that is being used for formal and informal mining activities (McMahon, 1999).

## **6. Social Environment**

The health of individuals and communities are significantly impacted by the social environment, which encompasses community interaction and connectedness, social community responses and the norms and values people share (PHAC, 2003). The amount of social support a community receives through the government, organizations and informal support further reflects the health status of the individuals residing in the community (PHAC, 2003). With respect to ASM, social organizations and relationships occur between the miners and their families, the mining companies and governments (Kuramoto, 2001). Additionally, the lives of miners and their families are often structured around the activities of mining and other agrarian sources of income, whether it be seasonal work or year round subsistence employment (Hilson and Banchirigah, 2009). Continuity and community connectedness in mining practices has been created between generations of artisanal and small-scale miners, as many miners continue to produce deposits in similar fashions to their forefathers, regardless of the advanced technology (Kuramoto, 2001).

Yet, the overall social organization of artisanal and small-scale miners place these people in weak and vulnerable positions of health, income and social status (Kuramoto, 2001; Kitula, 2006). Due to the lack of regulation and property rights for ASM in many countries, a large number of small-scale miners become displaced or face conflict with large-scale mining companies (Kitula, 2006; Kuramoto, 2001). These circumstances frequently occur for indigenous people in developing countries, where once the original owners of the land, they are now displaced from their settlements and sources of livelihood (Kitula, 2006). The aforementioned social organization, or lack thereof, contributes to the negative health effects that artisanal and small-scale miners often face (Keita, 2001). However, the community connectedness and cohesion that artisanal and small-scale miners and their families experience may nullify some of the negative aspects of ASM if the relationships are built on good moral foundations (Keita, 2001). Further investigation of Social Environments, specifically Social Support Networks as a determinant of health are later examined in this literature review.

## **7. Gender**

The most common theme in gender as a determinant of health encompasses the notion of women working in artisanal and small-scale mines. Approximately 3.5 to 4 million of the total 11.5 to 13 million artisanal miners globally are women who fulfill a variety of roles from the extraction and the amalgamation of the deposits to the organization of the mining camps (Heemskerk, 2003; Hinton et al., 2003). An additional 1.5 to 2 million women are indirectly involved in mining activities, such as selling commodities around the mining areas (Heemskerk, 2003). The proportion of women who are involved in ASM can vary from an estimated 10 to 50 percent according to

geographic location and reporting methods, which is often a barrier when determining current and accurate statistics in ASM (Heemskerk, 2003; Lahiri-Dutt, 2008). According to the literature, the role of women in the informal mining industry is reinforced by the low income and poor social status of the women's family (Heemskerk, 2000). Women often turn to ASM because of the lack of alternative employment options and to provide food for their families, consequently they are at a high risk of physical exploitation (Lahiri-Dutt, 2008). The physical demands can lead to a variety of health, safety and occupational working conditions, which in turn can lead to unemployment resulting from illness and food insecurity for the family (Lahiri-Dutt, 2008).

Conversely, when women participate in mining activities it allows for increased wealth and economic security, empowerment and authority in household decision making (Heemskerk, 2000). It has been suggested that women's participation in ASM should be recommended and encouraged in order to overcome the limited economic opportunities for women living in rural areas of developing countries (Heemskerk, 2003). Within ASM, a division of labour according to gender can be observed: males predominately assume more labour intensive and dangerous roles, while women are more frequently involved in lighter ASM work and daily chores (Lahiri-Dutt, 2008). This division of labour may occur out of individual preference, but it is important to note that it may also transpire due to social and gender norms and can vary depending on the country and culture (Lahiri-Dutt, 2008).

## **8. Health Services**

According to PHAC, health services include services that provide treatment and secondary prevention care, while also contributing to the overall improvement of

population health (PHAC, 2003). A common theme throughout the literature of ASM regarding health services is the lack of infrastructure in place to provide adequate health services to artisanal and small-scale miners (Hentschel et al., 2003; Keita, 2001). Often due to the temporary, seasonal, informal or illegal nature of ASM, public health infrastructure including sanitation, prevention and primary care capacities are scarce (Hentschel et al., 2003; Lahiri-Dutt, 2008). Again, due to the operating conditions of ASM, including regulation, governments and public health professionals have very limited funding and resources to provide services to the miners who are frequently located in isolated, remote and rural locations (Hentschel et al., 2003; Keita, 2001). Because of the remote locations of the mines, it is also very difficult for artisanal miners to reach health centres or medical professionals, thus compounding the problem of deficient health services (Keita, 2001). These conditions, combined with the presence of substance abuse and prostitution near extraction sites, creates an environment where sexually transmitted infections and other communicable diseases are easily spread (Hentschel et al., 2003). Because ASM camps are informal or illegal in most countries in the world, many do not qualify for proper public health facilities (Hentschel et al., 2003). Communicable diseases will likely continue to spread until these ASM camps are recognized as villages or until ASM is subjected to forms of regulation similar to large-scale mining operations (Deb et al., 2008).

## **9. Healthy Child Development**

The literature surrounding healthy child development focuses mainly, but not exclusively, on child labour occurring within informal mining. Child labour is a common theme, as many children are forced to work in mines with their parents in order to help

provide for the family (Kuramoto, 2001; Hilson, 2008). The challenges associated with estimating the number of artisanal miners are also present when trying to determine how many children are informally participating in ASM; this must be remembered when statistics are presented (Kuramoto, 2001). As of 2001, it has been estimated that 50,000 children partake in all phases of artisanal mining activities, from drilling, to preparing explosives, to grinding and amalgamation of deposits (Kuramoto, 2001). Child labour has a significant impact on healthy child development, as children who work in mines are exposed to the same occupational health risks as adults, such as an elevated exposure to mercury that is burnt in the homes when separating gold from ore (Counter et al., 2002). However, the detrimental health effects are amplified in children as their bodies are still growing and developing (Keita, 2001). Children and babies who are present at the site of ASM are at risk of developing a host of serious health effects including:

“Apart from their mothers’ presence on the sites, babies are exposed very young to dust and noise caused by pestles. Among other physical risks and constraints endured by children on sites, a list should include: respiratory infections and silicosis caused by fine dust; dumbness risk caused by permanent noise from pestles and hammers; fatigue from hard manual labour to crush and grind minerals; injury risk from flying stone fragments; ocular and various dermatological afflictions; child prostitution. The precarious state of some of children’s nutritional situation constitutes another risk factor on mining sites” (Keita, 2001, 18).

Children are also susceptible to neurological damage if they are exposed to mercury, even at low doses, as their developing nervous system is vulnerable to mercury exposure (Counter et al., 2002). Moreover, children who participate in ASM often do not attend school, and if they do, it is often sporadic, yielding a poor educational experience and a poor scholastic outcome (Kuramoto, 2001).

Regulation and policy also plays a large factor in healthy child development with respect to child labour. Governments and policy makers find it hard to regulate artisanal mining, let alone child labour in artisanal mining (Hilson, 2008; Kuramoto, 2001). One side of the argument for the regulation of child labour in ASM suggests that the economic benefit from the production of artisanal mining often outweighs the government's capacity to regulate ASM production (Hilson, 2008). Conversely, the other argument states that child labour in ASM must be abolished, regardless of the potential economic benefits of this poverty-driven activity (Hilson, 2008). According to a policy document produced by the International Labour Organization (ILO) in 1999 entitled, *Worst Forms of Child Labour*, mining and quarrying are considered the most inhumane forms of child labour (Hilson, 2008). The extreme hazardous risk for children developing a disease or injury while engaging in artisanal or small-scale mining provides a sense of urgency for the elimination of this form of child labour (Hilson, 2008).

## **10. Income and Social Status**

Income and social status as a determinant of health appears frequently in the literature surrounding ASM. Many of the themes, such as employment and regulation will be reiterated in this section as income and social status is often discussed in conjunction with many of the other determinants of health. Furthermore, the determinant of income and social status has also been used to reflect economic aspects of ASM. This is important to note, especially when reviewing *Appendix 4: Tool for Systematic Review of ASM*.

The driving forces behind AMS are often poverty, the lack of formal sector employment and a lack of economic development (Hilson et al., 2007; Mutemeri and



Petersen, 2002). Researchers have alluded to the idea that these driving forces behind ASM generate a perpetuating cycle since poor technology can lead to inefficient production, which then contributes to a lack of investments and low economic outcomes (*Appendix 5*) (Hilson, 2008). Through the examination of mining in Ghana, where there is a high prevalence of ASM, the relationship between employment and poverty can be clearly demonstrated (Hilson et al., 2007). According to a Ghana Living Standards Survey, approximately 19 million people live in poverty in Ghana; this population can be classified into two groups- agriculture and informal economy subsistence (Hilson et al., 2007; ILO, 2004). Apart from the working population involved in agriculture, two thirds of the employment sector in Ghana is involved directly and indirectly in the informal economy, which includes ASM (ILO, 2004). Although ASM is considered part of the informal economy, the Small Scale Gold Mining Law that was passed in 1989, created regulation in the economy of the exports produced by ASM (Hilson et al., 2007). Since the creation of this law in Ghana, revenues generated have earned an estimated US \$117 million from 315,000 oz of gold (Hilson, 2002). Not only does ASM create formal and informal revenue for the country's economy through its exports, but it also provides a source of income for the Ghanaians (Hilson, 2002; Hilson et al., 2007). In Ghana an estimated 200,000 people work illegally as galamsey miners (Hilson et al., 2007). The salaries for these miners vary depending on the type of deposit being mined, the economic trade value of the deposit being mined and the type of mining work being done (Hentschel et al., 2003). Moreover, inequality between males and females is evident when examining income and social status of ASM miners. Women and children as vulnerable populations are greatly affected by poverty and earn a disproportionately

lower income compared to their male counterparts (Heemskerk, 2000). Women and children also are regarded as having a different social status than males involved in ASM; many initiatives are now focusing on alternative employment avenues for women and children, such as agriculture and food production (Hilson and Banchirigah, 2009). Through initiatives supporting alternative employment sectors, women and children would still be able to support their families, yet their health and well-being would not be put in jeopardy. This notion is supported through sustainable development, which is discussed later in this literature review.

### **11. Personal Health Practices**

Many detrimental occupational health effects that were highlighted for children in Determinant of Health # 9: Healthy Childhood Development also overlaps with Personal Health Practices (PHAC, 2003). Contributing factors to the poor personal health practices of artisanal and small-scale miners are the lack of sanitation and public health facilities, the difficult and physically-demanding working conditions and isolation of the extraction sites (Keita, 2001; Hentschel et al., 2003). Because ASM is often not recognized as a permanent source of employment, structures built at the ASM extraction sites offer little security and protection from intruders and weather (Lahiri-Dutt, 2008; Keita, 2001). Further, the harsh weather and working conditions place the miners and the families who work directly or indirectly at extraction sites in a vulnerable position. For example, the villages surrounding ASM extraction sites in various countries in Africa are constructed from temporary materials, such as straw and mud huts (Keita, 2001). These situations increase the proliferation of communicable diseases in mining camps and in the homes of the miners (Keita, 2001). The most common health problems found in these

areas are malaria, gastrointestinal tract problems (i.e. diarrhea, enteric diseases), respiratory infections (i.e. silicosis, tuberculosis and pneumonia), arthritis, leukemia, deafness, blindness, dermatitis, STIs, malnutrition, an increased prevalence of HIV/AIDS and the associated effects of chemical poisoning (Lahiri-Dutt, 2008; Keita, 2001; Hentschel et al., 2003; Appel, 2005). These common health problems associated with ASM are compounded by an increased prevalence of substance abuse in the forms of alcohol, amphetamines or other drug and inhalant-type substances (Keita, 2001). In a study by Keita (2001) on artisanal and small-scale mining in Mali, it was found that to “avoid losing heart”, miners often engaged in harmful health behaviours and made poor personal health decisions such as the aforementioned substance abuse activities, prostitution and crime (Keita, 2001, 18). Poor nutrition of miners also exacerbates the proliferation of communicable diseases as meals often are comprised of cereals or rice and thus lack essential vitamins necessary for maintaining health (Keita, 2001). It has been suggested that regulation of ASM would help to lower the prevalence of communicable diseases and improve personal health practices. However, in order for this to occur there must be a collaborative effort from all organizations involved in ASM (Deb et al., 2008).

## **12. Social Support Networks**

Social support networks as a determinant of health in the context of ASM is not commonly discussed in the literature, whereas the determinant Social Environment has a broader definition and is more frequently mentioned. The literature that does investigate the social support networks of ASM highlights the importance of where the miners originate, the communal work that is undertaken and the inclusion of families in the

different aspects of ASM (Kuramoto, 2001). A strong sense of social cohesion is created when artisanal and small-scale miners are from the same community and then moves together to partake in ASM (Kuramoto, 2001). Social cohesion and social support networks appear to be formed by males working in ASM through atypical networks, whereas females typically experience social exclusion directly related to ASM activities (Fisher, 2007). However, the creation of social support networks for women who are involved in indirect forms of ASM are typically formed by their family, including their children (Lahiri-Dutt, 2008). Although this can be viewed as detrimental to the health of the vulnerable populations of women and children (*see #7 Gender, #9 Healthy Child Development and #11 Personal Health Practices*), the argument can be made that having the family present near the extraction sites provides mental, physical and emotional support (PHAC 2003; Lahiri-Dutt, 2008)

Although the description of social support networks primarily includes networks of families, friends and communities, in the context of ASM, social support networks should be expanded to include formal and informal organizations for artisanal and small-scale miners. This argument can be made as these organizations provide technical, regulatory and social support, which in turn may improve the health of the miners (Swiss Agency for Development and Cooperation, 2009). When examining the role of Peruvian miners in ASM, support programs and initiatives have evolved to encompass a variety of issues that artisanal miners experience (Kuramoto, 2001). These mining support programs can range from mining logistics, regulation and policy including child labour, social and physical environment impacts and economic parameters (Kuramoto, 2001). If the

definition of social support networks is expanded, it then includes an array of other determinants of health.

## **REGULATION/ POLICY**

From the vast amount of literature which discuss the elements of regulation and/ or policy surrounding the issues of ASM, it is apparent that this topic cannot go ignored when addressing the determinants of health. Regulation and policy are greatly intertwined with the twelve determinants of health and has a large impact on how the determinants are affected by ASM. Similar to the other determinants of health, regulation varies depending on the country, government and the type of mining that is occurring, making it difficult to provide generalizations when considering all of the exceptions. Although there is significant variation between countries, most mining policies which are controlled through governing legislation and laws are written in documents filled with legal jargon and not in layman's terminology (Mutemeri and Petersen, 2002). Consequently, for the artisanal and small-scale miners who can access the policies, comprehension of the policy is often lacking. However, the greatest problem with governmental policies regulating ASM is the lack of awareness that national laws and regulations exist, thus artisanal and small-scale miners are unintentionally violating the law (Mutemeri and Petersen, 2002).

As previously mentioned, governments and their regulations can differ significantly. This is exemplified through two case studies: Mongolia and southern Africa. These two case studies were chosen to demonstrate how much regulation can vary. In Mongolia, ASM, also known as 'ninja' or 'informal placer' mining is illegal which has created conflict among the government, large-scale mining companies and the

artisanal and small-scale miners (Dore and Nagpal, 2006). Initially ASM activities were limited to panning for deposits, such as gold, from the waste tailings of large-scale mining companies; an assumption was made that resources were split fairly. However, due to the illegal status of ASM and the lack of regulations over the tailings, conflict ensued when large-scale mining companies included tailings as part of their mining resources, making it illegal for ASM activities to take place on the premises of commercial mining (Dore and Nagpal, 2006). In this instance, the mining companies took control of the regulation, but it is more common for governments to be the ones creating policies. In countries where ASM is illegal and unregulated, many governments confront negative issues of ASM by attempting to shut down the mines (Gunson and Veiga, 2005). This approach often creates distrust between the governments and the miners, intensifying the struggle to enforce laws and policies, especially in the areas of environmental management and occupational safety (Marshall et al., 2007).

In southern Africa, an estimated 80% to 90% of ASM mining operations are informal, out shadowing the legally registered artisanal and small-scale miners that are active (Dreschler, 2001). In Malawi, artisanal and small-scale miners can be licensed and thus operate legally within the country. Licensing has been strongly encouraged by the government as it allows for greater monitoring and management of the sector, while enforcing better ASM protocols (Dreschler, 2001). In order to increase sustainability within the small-scale mining sector in Malawi, it has been recommended that legislation be improved through policies that are created to support investments and production (Dreschler, 2001). Compared to Malawi, there are differences in how ASM is regulated in South Africa, as it is regulated the same as large-scale mining operations (Mutemeri

and Petersen, 2002). However, the difference between large and small-scale mining in South Africa is that enforcement and compliance of regulations are often much lower in comparison to large-scale mining (Mutemeri and Petersen, 2002). Legislation is being improved in terms of increasing sustainability within ASM and enhancing the contribution of ASM to the economy on all levels- local, provincial, and national (Mutemeri and Petersen, 2002; Quiroga, 2002). Although regulation and policy making is country and context specific, a common recommendation made in the literature is that regulation and policy should incorporate sustainable development and should aim to improve the environmental management and occupational health and safety of the miners, while positively contributing to the economy and income of the country and the miners, respectively (Marshall et al., 2007; Mutemeri and Peteresen, 2002; Dreschler, 2001; Quiroga, 2002).

## **DISCUSSION**

As demonstrated throughout this literature review, ASM is completely intertwined with the twelve determinants of health. Another trend that emerged was that the determinants of health were also closely interconnected. It is apparent that ASM has a significant impact on many aspects of the health and well-being of the miners, families, communities and countries and that their impact is not going unnoticed (Hentschel et al., 2003). Governments and policy makers are becoming increasingly aware of the significance of this sector as a way to generate income for the country, improve employment opportunities and consequently help alleviate poverty (Hentschel et al., 2003). As a result of the rapid growth of ASM in some developing countries, concern has been expressed from international development stakeholders over the negative and

detrimental aspects which have been outlined in this literature review, that coincide with ASM (Hentschel et al., 2003).

### ***Sustainable Development***

Stemming from the mounting concern regarding the negative aspects associated with ASM, sustainability of this sector is being addressed. Previously, the majority of initiatives to improve the ASM sector have focused on the logistics and operations of ASM including productivity, environmental impacts and the legal status of artisanal and small-scale miners (Hentschel et al., 2003). Further, the initiatives failed to include ASM communities and neighbouring communities, focusing mainly on the artisanal and small-scale miners and their operations (Hentschel et al., 2003). Over the last decade a shift has occurred where initiatives for this sector are now focusing more on sustainable development rather than reactive program development (Gunson and Veiga, 2005). It has been recommended that governments stop trying to abolish ASM, which perpetuates harmful social, environmental and health outcomes, and concentrate their efforts on positive ways to develop communities and alleviate poverty (Hentschel et al., 2003).

There have been several proposed ways to create sustainable development in the ASM sector including the expansion of auxiliary employment sectors, providing training and education to artisanal and small-scale miners, and a rearrangement of organizational structures (Hinton et al., 2003; Hentschel et al., 2003; Keita, 2001). Through the promotion of enterprises, other than ASM, that have the potential to succeed in communities located near ASM sites, such as agricultural and food production, local economies may be stimulated with the hopes of decreasing poverty. When the revenue produced from ASM is re-invested into the area where ASM occurs, the communities



have a chance to flourish (Hentschel et al., 2003; Hinton et al., 2003). In order for this to occur in a sustainable manner, training and education must be provided to the miners regarding proper environmental and resource management (Hentschel et al., 2003). Because there is little regulation and enforcement of ASM practices, there is often a significant lack of training and education provided to artisanal and small-scale miners, thus leading to unsustainable mining practices (Hinton et al., 2003). Training and education is crucial to improve safety in terms of chemical handling, land and waste management, health and occupational hazards, and proper protocol of mine and machine conduct (Hinton et al., 2003). Another recommendation that has been made to increase the sustainability of ASM and improve the social, environment and health outcomes is to rearrange the organizational structures of ASM. It has been suggested and previously noted that when governments attempt to close ASM sites, distrust is created among the miners towards the governments (Gunson and Veiga, 2005). A more effective relationship that could foster sustainable development may be to promote and support the development of cooperatives or associations among artisanal and small-scale miners; an approach that is being adopted in countries like Mongolia through a program run by the Swiss Agency for Development (Hentschel et al., 2003; Gunson and Veiga, 2005; Swiss Agency for Development and Cooperation, 2009). The formation of cooperatives among miners would play an important role in increasing the capabilities of the miners and would allow for increased collaboration among international organizations and miners. The cooperative can be utilized as an avenue for encouraging and supporting proper environmental practices and improved standards in health and occupational safety (Hentschel et al., 2003). All of these proposed opportunities for sustainable development

can be adapted for different countries and contexts, as well as for vulnerable populations such as women and children (Hinton et al., 2003). Nonetheless, it is important to remember that without a realistic framework and accountability guiding these proposed recommendations, there is an increased likelihood that sustainable development would not occur and the effects of ASM on communities would continue to be negative (Hentschel et al., 2003).

### ***Limitations***

As with all reviews of this kind, there are gaps in the literature that may limit the generalizability of the findings reported here. Because of the nature of ASM, often unmonitored and practiced in remote locations, systematic research is often limited. In order to ensure that the maximum number of articles and reports were considered, I used a number of search terms in Google Scholar. Google Scholar allows for inclusion of a breadth of themes reflecting the diversity of the determinants of health as opposed to discipline-specific databases. However, within Google Scholar it is difficult to determine or control the scope of the search, and it is challenging to establish comprehensiveness or completeness of the results. Specifically, grey literature may have been missed in the literature review as it is often not written in English and is often more difficult to obtain. Also, and because the focus here is on the specific association of ASM and health, the broader literature that focuses on the relationship between particular environmental exposures (e.g., mercury) and health was not reviewed. The reader should be aware that there is a sizeable literature on such exposures that may not have been considered in this review.

Although these are important limitations, it is important to underscore the objective of this study: to review the major themes which have appeared in the literature on ASM that reflects on the multi-level determinants of health. Every effort was made to minimize the impact that these limitations might have on the interpretation of results.

## **CONCLUSION**

Many themes have been mentioned throughout this literature review of ASM and its interconnectedness with the determinants of health, as defined by the Public Health Agency of Canada (2003). It is apparent that ASM is very intertwined with the determinants of health; as well, the determinants are very interrelated with one another. Thus, it is hard to avoid overlap and references to other determinants when examining an individual determinant in relation to ASM. Throughout this literature review, the income and economic pressures were highlighted in the majority of the determinants, as poverty and the need for an alternative source of employment/ livelihood often serve as an attraction to ASM (Lahiri-Dutt, 2007). These needs are not confined to men, as both women and children participate in ASM for reasons such as, gaining empowerment and decision making through personal income, a need for an alternative livelihood or to help contribute to the family income (Heemskerk, 2000; Lahiri-Dutt, 2008). Regulation/ policy are also reoccurring themes throughout the literature, as each country's government takes a different approach when addressing ASM. In some countries ASM is regarded as illegal and thus there is a push to abolish ASM activities all together. On the other hand, other governmental tactics act to increase collaboration with artisanal and small-scale miners and their organizations to help improve mining techniques, environmental management, and the health and safety of the miners. Arguments can be

made for a number of approaches, but all should include strong environmental management strategies and improved health and occupational safety for the miners and their families. Because ASM often occurs in remote, rural and isolated locations and where there is little law enforcement, it is unlikely that the abolishment of ASM will be effective. Rather than perpetuating a host of negative and detrimental outcomes, regulation should strive for increased sustainability and improvement of the lives of miners and their families.

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## **APPENDICES**

### **Appendix A: Public Health Agency of Canada's Determinants of Health**

In alphabetical order:

1. Biology and Genetic Endowment
2. Culture
3. Education
4. Employment/ Working Conditions
5. [Physical] Environments
6. [Social] Environments
7. Gender
8. Health Services
9. Healthy Child Development
10. Income and Social Status
11. Personal Health Practices and Coping Skills
12. Social Support Networks
- 
13. Regulation and Policy- is not a determinant of health as outlined in PHAC, but is crucial to include when examining ASM

## **Appendix B:**

### **ASM characterized by a number of conditions, as defined by Hentschel et al., 2003**

- Lack of or limited use of mechanization, and a lot of physically demanding work
- Low level of occupational safety and health care
- Poor qualification of personnel at all levels of the operation
- Inefficiency in exploitation and processing of mineral production (low recovery value)
- Exploitation of marginal and/or very small deposits, which are not economically exploitable by mechanized mining
- Low level of productivity
- Low level of salaries and income
- Periodic operation by local peasants by season or according to the market price development
- Lack of social security
- Insufficient consideration of environmental issues
- Chronic lack of working and investment capital
- Most working without legal mining titles

(Hentschel et al., 2003)

**Appendix C:**  
**Database: Google Scholar Search Terms Results**

**Table 1. Database: Google Scholar Search Terms Results**

<b>Search terms</b>	<b>Number of files produced</b>	<b>Number of terms used in tool for systematic review</b>
<b>Artisanal mining</b>	23,200	39
<b>Artisanal mining health</b>	19,600	0
<b>Artisanal mining social determinants</b>	6,530	0
<b>Small scale mining</b>	1,490,000	10
<b>Small scale mining health</b>	413,00	0
<b>Small scale mining social determinants</b>	55,400	0
<b>Informal mining</b>	261,000	15
<b>Informal mining health</b>	150,000	0
<b>Informal mining social determinants</b>	37,800	0
<b>Ninja mining</b>	4,980	5
<b>Ninja mining health</b>	2,460	4
<b>Ninja mining social determinants</b>	174	1
<b>Small scale mining in Mongolia</b>	21,200	5
<b>Artisanal and small scale mining</b>	18,800	44

**Appendix D:**  
**Tool for systematic literature review of artisanal and small-scale mining**

RefWorks Number	Citation <sup>1</sup>	Source <sup>2</sup>	Copy Obtained? <sup>3</sup>	Geographic Location <sup>4</sup>	Determinants of Health														
					1	2	3	4	5	6	7	8	9	10	11	12	13		
98	Addy, S.N. 1998. Ghana: revival of the mineral sector.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Ghana						X						X			X
77	Andrew, J.S. 2003. Potential application of mediation to land use conflicts in small-scale mining.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Global				X	X	X						X			
67	Andrews-Speed, P., Ma, G., Shao, B. and Liao, C. 2005. Economic responses to the closure of small-scale coal mines in Chongqing, China.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	China				X		X						X			X
101	Andrews-Speed, P., Yang, M., Shen, L. and Cao, S. 2003. The regulation of China's township and village coal mines: a study of complexity and ineffectiveness.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	China					X										X
150	Appel, P.W.U. 2005. Small-scale	DB: Google Scholar	Journal Article	Kyrgyzstan and Mongolia			X		X							X	X		

<sup>1</sup> Author first so they can be alpha sorted, include date and rest of citation details.

<sup>2</sup> Where was the reference found? DB = database; Search Terms used to find the reference.

<sup>3</sup> Make note of any of the documents that you have obtained paper or electronic copies.

<sup>4</sup> Where noted, what is the geographic reference point for the article (i.e. an African country? S. America? Mongolia?)

	mining-hazards and opportunities in Kyrgyzstan and Mongolia.	Search Terms: small scale mining	(Electronic)															
95	Appiah, H. 1998. Organization of small scale mining activities in Ghana.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Ghana				X							X			
70	Aryee, B.N.A., Ntibery, B.K. and Atorkui, E. 2003. Trends in the small-scale mining of precious minerals in Ghana: a perspective on its environmental impact.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Ghana			X	X							X			X
87	Aspinall, C. and Eng, P. 2001. Small-scale mining in Indonesia.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Indonesia				X	X	X		X	X					X
129	Attwood, J. 2008. Environmental Management Pollution and Contamination – The Case of Khonger soum.	DB: Google Scholar Search Terms: artisanal and small scale mining	Conference Proceedings (Electronic)	Mongolia				X										
141	Aubynn, A. 2008. Sustainable solution or a marriage of inconvenience? The coexistence of large-scale mining and artisanal and small-scale mining on the Abosso Goldfields concession in	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Ghana											X			X

	Western Ghana.																		
66	Babut, M., Sekyi. R., Rambaud, A., Potin-Gautier, M., Tellier, S., Bannerman, W. and Beomjpf, C. 2003. Improving the environmental management of small-scale gold mining in Ghana: a case study of Dumasi.	DB: Google Scholar Search Terms: small scale mining	Journal Article (Electronic)	Ghana					X										
	Banchirigah, S.M. 2006. How have reforms fuelled the expansion of artisanal mining? Evidence from sub-Saharan Africa.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	sub-Saharan Africa				X		X				X					X
38	Barry, M. 1996. Regularizing informal mining.	DB: Google Scholar Search Terms: informal mining	Journal Article (Electronic)	World Bank in Washington D.C.; international roundtable on artisanal mining					X		X			X					X
102	Betancourt, O. Narvaez, A. and Roulet, M. 2005. Small-scale gold mining in the Puyango River Basin, Southern Ecuador: a study of environmental impacts and human exposures.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Southern Ecuador	X				X										
36	Biller, D. 1994. Informal gold mining and mercury pollution in Brazil.	DB: Google Scholar Search Terms: informal mining	Book Whole (Electronic)	Brazil					X					X					X
33	Blackwood, G.M.	DB: Google	Journal	Indonesia					X										

	and Edinger, E.N. 2007. Mineralogy and trace element relative solubility patterns of shallow marine sediments affected by submarine tailings disposal and artisanal gold mining, Buyat-Ratototok district, North Sulawesi, Indonesia.	Scholar Search Terms: artisanal mining	Article (Electronic)															
122	Boese-O'Reilly, S. 2008. Environmental risks to health from artisanal gold mining worldwide.	DB: Google Scholar Search Terms: ninja mining	Conference Proceedings (Print)	Mongolia				X										
54	Bridge, G. 2004. Contested terrain: mining and the environment.	DB: Google Scholar Search Terms: informal mining	Journal Article (Electronic)	International		X		X	X				X					X
120	Burmaa, B., Saijaa, N., Unursaikhan, S., Ichionkhorloo, B. and Tsetsegsaikhan, B. 2009. Study on Health Adverse Effects Related to Mercury Exposure.	DB: Google Scholar Search Terms: informal mining	Conference Proceedings (Print)	Mongolia				X										
140	Bush, R. 2008. 'Soon there will be no-one left to take the corpses to the morgue': Accumulation and abjection in Ghana's mining communities.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Ghana				X	X		X		X	X				X
143	Cartier, L.E. 2008. Livelihoods and production cycles in	DB: Google Scholar Search Terms:	Journal Article (Electronic)	Madagascar				X	X					X		X		X

	the Malagasy artisanal ruby-sapphire trade: A critical examination.	artisanal and small scale mining																	
72	Castro, S.H. and Sanchez, M. 2003. Environmental viewpoint on small-scale copper, gold and silver mining in Chile	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Chile					X							X	X		X
31	Chakravorty, S.L. 2001. Artisanal and small-scale mining in India.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	India				X	X	X						X			X
50	Chibunda, R.T. 2008. Comparative sensitivity of Caridina nilotica, Haplochromis nubilus, Bulinus africanus and Bulinus forskalii from Lake Victoria, Tanzania to mercury chloride.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Tanzania					X										
1	Clemente, E., Sera, K., Futatsugawa, S. and Murao, S. 2004. PIXE analysis of hair samples from artisanal mining communities in the Acupan region, Benguet, Philippines.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Philippines	X				X										
58	Cortes-Maramba, N., Reyes, J.P., Francisco-Rivera, A.T., Akagi, H., Sunio, R. and Panganiban, L.C. 2006. Health and environmental	DB: Google Scholar Search Terms: small scale mining	Journal Article (Electronic)	Philippines					X										



	assessment of mercury exposure in a gold mining community in Western Mindanao, Philippines.																		
57	Crispin, G. 2003. Environmental management in small scale mining in PNG.	DB: Google Scholar Search Terms: informal mining	Journal Article (Electronic)	Papua New Guinea					X	X					X				X
71	de Lacerda, L. 2003. Updating global Hg emissions from small-scale gold mining and assessing its environmental impacts.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Global					X										X
37	de Oliveira Santos, E.C., de Jesus, I.M., da Silva Brabo, E., Brito Loureiro, E.C., da Silva Mascarenhas, A.F., Weirich, J., Camara, VdM. And Cleary, D. 2000. Mercury exposures in riverside Amazon communities in Para, Brazil.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Brazil					X	X									
47	Deb, M., Tiwari, G. and Lahiri-Dutt, K. 2008. Artisanal and small scale mining in India: selected studies and an overview of the issues.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	India					X	X					X				X
52	Dietrich, C. 2000. Power struggles in the diamond fields.	DB: Google Scholar Search Terms: informal mining	Journal Article (Electronic)	Angola					X						X				X

32	Dominique, Y., Muresan, B., Duran, R., Richard, S. and Boudou, A. 2007. Simulation of the chemical fate and bioavailability of liquid elemental mercury drops from gold mining in Amazonian freshwater systems.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Amazon					X									
138	Dondeyne, S., Ndonguru, E., Rafael, P. and Bannerman, J. 2008. Artisanal mining in central Mozambique: Policy and environmental issues of concern.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Mozambique				X	X					X				X
17	Dore, G. and Nagpal, T. 2006. Urban transition in Mongolia: Pursuing sustainability in a unique environment.	DB: Google Scholar Search Terms: ninja mining health	Journal Article (Electronic)	Mongolia		X	X	X	X	X		X		X				X
74	Dreschler, B. 2001. Small-scale mining and sustainable development within the SADC Region.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Southern Africa				X	X		X		X	X				X
34	Edinger, E.N., Siregar, P.R. and Blackwood, G.M. 2007. Heavy metal concentrations in shallow marine sediments affected by submarine tailings disposal and	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Indonesia					X									

	artisanal gold mining, Buyat-Ratototok district, North Sulawesi, Indonesia.																		
61	Farr, M. 2006. Mining in Mongolia.	DB: Google Scholar Search Terms: small scale mining in Mongolia	Journal Article (Electronic)	Mongolia															X
20	Fields, S. 2001. Tarnishing the earth: gold mining's dirty secret.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)					X											
2	Fisher, E. 2007. Occupying the margins: Labour integration and social exclusion in artisanal mining in Tanzania.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Tanzania		X			X	X				X			X	X	
136	Fisher, E., Mwaipopo, R., Mutagwaba, W., Nyange, D. and Yaron, G. 2009. "The ladder that sends us to wealth": Artisanal mining and poverty reduction in Tanzania.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Tanzania			X							X	X				X
103	Garvin, T., McGee, T.K., Smoyer-Tomic, K.E. and Aubynn, E.A. 2009. Community-company relations in gold mining in Ghana.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Ghana					X					X			X	X	
85	Ghose, M.K. 2003. Promoting cleaner production in the	DB: Google Scholar Search Terms:	Journal Article (Electronic)				X	X	X					X					X

	Indian small-scale mining industry.	artisanal and small scale mining																	
43	Grandjean, P., White, R.F., Nielsen, A., Cleary, D. and deOliveira Santos, E.C. 1999. Methylmercury neurotoxicity in Amazonian children downstream from gold mining.	DB: Google Scholar Search Terms: informal mining	Journal Article (Electronic)	Amazon	X				X					X					
133	Grätz, T. 2009. Mortalities, risk and rules in West African artisanal gold mining communities: A case study of Northern Benin.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Western Africa-Northern Benin		X				X	X				X	X	X		
93	Gueye, D. 2001. Small-scale mining in Burkina Faso.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Burkina Faso				X	X	X	X			X	Child labour	X			X
3	Gunson, A.J. and Jian, Y. 2001. Artisanal mining in the People's Republic of China.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	China					X		X			X	X			X	X
94	Gunson, A.J. and Veiga, M.M. 2004. Mercury and artisanal mining in China.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	China					X						X				X
28	Heemskerk, M. 2003. Self-employment and poverty alleviation: Women's work in artisanal gold	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Suriname, South America				X		X	X			X					

	mines.																		
144	Heemskerk, M. 2000. Gender and gold mining: The case of the Maroons of Suriname.	DB: Google Scholar Search Terms: small scale mining	Journal Article (Electronic) Working Paper	Suriname, South America		X				X	X			X					
75	Hentschel, T., Hruschka, F., Priester, M. and Mining, M. 2003. Artisanal and small-scale mining: Challenges and opportunities.	DB: Google Scholar Search Terms: artisanal and small scale mining	Book Whole (Electronic)	Countries in Africa, Asia and South America				X	X		X	X	X	X					X
4	Hentschel, T., Hruschka, F. and Priester, M. 2002. Global report on artisanal and small scale mining.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Global				X	X		X	X	X	X					X
131	Hilson, G. 2009. Small-scale mining, poverty and economic development in sub-Saharan Africa: An overview.	DB: Google Scholar Search Terms: small scale mining	Journal Article (Electronic)	sub-Saharan Africa				X	X					X					X
23	Hilson, G. 2008. 'A load too heavy': Critical reflections on the child labor problem in Africa's small-scale mining sector.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Africa (sub-Saharan Africa)										X					X
92	Hilson, G. 2006. Abatement of mercury pollution in the small-scale gold mining industry: restructuring the policy and research agendas.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	sub-Saharan Africa, Latin America and Asia			X												X
10	Hilson, G. 2003. The socio-economic	DB: Google Scholar	Book Whole (Electronic)	Developing Countries				X	X	X	X			X	X				X

	impacts of artisanal and small-scale mining in developing countries.	Search Terms: artisanal mining																
79	Hilson, G. 2002. The environmental impact of small-scale gold mining in Ghana: identifying problems and possible solutions.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Ghana					X									X
91	Hilson, G. 2001. A contextual review of the Ghanaian small-scale mining industry.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Ghana				X	X					X				X
21	Hilson, G. and Banchirigah, S.M. 2009. Are alternative livelihood projects alleviating poverty in mining communities? Experiences from Ghana.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Ghana				X		X				X				X
80	Hilson, G., Hilson, C.J. and Pardie, S. 2007. Improving awareness of mercury pollution in small-scale gold mining communities: challenges and ways forward in rural Ghana.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Ghana					X					X				X
147	Hilson, G., Yakovleva, N. and Banchirigah, S.M. 2007. 'To move or not to move':	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Ghana					X	X				X				X

	Reflections on the resettlement of artisanal miners in the Western Region of Ghana.																	
5	Hinton, J.J., Veiga, M.M. and Beinhoff, C. 2003. Women and artisanal mining: gender roles and the road ahead.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Developing Countries		X		X	X		X		X	X				X
6	Hinton, J.J., Veiga, M.M. and Veiga, A.T.C. 2003. Clean artisanal gold mining: a utopian approach?	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	General				X	X					X				X
25	Ikingura, J.R., Akagi, H., Mujumba, J. and Messo, C. 2006. Environmental assessment of mercury dispersion, transformation and bioavailability in the Lake Victoria Goldfields, Tanzania.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Tanzania					X									
99	Ikingura, J.R., Mutakyahwa, M.K.D. and Kahatano, J.M.J. 1997. Mercury and mining in Africa with special reference to Tanzania.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Africa-Tanzania					X									
63	Jamba, S. 2004. Gold: The new rush.	DB: Google Scholar Search Terms: ninja mining health	Journal Article (Electronic)	Mongolia										X				

89	Kambani, S.M. 2003. Small-scale mining and cleaner production issues in Zambia.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Zambia					X									X
90	Keita, S. 2001. Study on artisanal and small-scale mining in Mali.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Mali					X		X	X		X	X			X
40	Kibadi, K., Panda, M., Tamfum, J.J.M., Fraga, A.G., Longatto Filho, A., Anyo, G., Pedrosa, J., Nakazawa, Y., Suykerbuyk, P. and Meyers, W.M. 2008. New foci of buruli ulcer, Angola and Democratic Republic of Congo.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Angola and Democratic Republic of Congo				X								X		
104	Kitula, A.G.N. 2006. The environmental and socio-economic impacts of mining on local livelihoods in Tanzania: A case study of Geita District.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Tanzania		X			X	X					X			X
105	Kumah, A. 2006. Sustainability and gold mining in the developing world.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Developing Countries														X
26	Kuramoto, J.R. 2001. Artisanal and informal mining in Peru.	DB: Google Scholar Search Terms: informal mining	Journal Article (Electronic)	Peru					X	X					X	X	X	X
16	Lahiri-Dutt, K. 2008. Digging to survive: Women's	DB: Google Scholar Search Terms:	Journal Article (Electronic)	South Asia		X	X	X			X			X	X			X







81	Mol, J.H. and Ouboter, P.E. 2004. Downstream effect of erosion from small-scale gold mining on the instream habitat and fish community of a small neotropical rainforest stream.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	South America					X									
24	Moretti, D. 2007. Ecocosmologies in the making: New mining rituals in two Papua New Guinea societies.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Papua New Guinea		X			X	X							X	X
27	Moretti, D. 2006. The gender of the gold: an ethnographic and historical account of women's involvement in artisanal and small-scale mining in Mount Kaindi, Papua New Guinea.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Papua New Guinea		X		X		X				X				X
18	Morris, E. and Bruun, O. 2005. Promoting employment opportunities in rural Mongolia.	DB: Google Scholar Search Terms: ninja mining health	Journal Article (Electronic)	Mongolia			X	X	X					X			X	X
12	Murao, S., Naito, K., Dejidmaa, G. and Sie, S.H. 2006. Mercury content in electrum from artisanal mining site of Mongolia.	DB: Google Scholar Search Terms: ninja mining	Journal Article (Electronic)	Mongolia					X									
62	Murao, S., Tumenbayar, B., Sera, K., Futatsugawa, S. and	DB: Google Scholar Search Terms: small scale	Journal Article (Electronic)	Mongolia					X									

	Waza, T. 2004. Finding of high level arsenic for Mongolian villagers' hair.	mining in Mongolia																
88	Mutemeri, N. and Petersen, F.W. 2002. Small-scale mining in South Africa: past, present and future.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	South Africa			X	X	X					X				X
86	Mwaiipopo, R., Mutagwaba, W., Nyange, D. and Fisher, E. 2004. Increasing the contribution of artisanal and small-scale mining to poverty reduction in Tanzania.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Tanzania						X		X		X				X
132	Nyame, F.K., Grant, J.A. and Yakovleva, N. 2009. Perspectives on migration patterns in Ghana's mining industry.	DB: Google Scholar Search Terms: informal mining	Journal Article (Electronic)	Ghana				X						X				X
84	Peterson, G.D. and Heemskerk, M. 2002. Deforestation and forest regeneration following small-scale gold mining in the Amazon: the case of Suriname.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Suriname					X									
148	Pomfret, R. 2000. Transition and democracy in Mongolia.	DB: Google Scholar Search Terms: small scale mining in Mongolia	Journal Article (Electronic)	Mongolia										X				X
9	Quiroga, E.R. 2002.	DB: Google	Conference	Bolivia				X	X	X				X		X		X

	The case of artisanal mining in Bolivia: Local participatory development and mining investment opportunities.	Scholar Search Terms: artisanal mining	Proceedings (Electronic)																		
51	Roberts, J.T. 1995. Trickle down and scrambling up: The informal sector, food provisioning and local benefits of the Carajas mining "Growth Pole" in the Brazilian Amazon.	DB: Google Scholar Search Terms: informal mining	Journal Article (Electronic)	Brazil (Amazon)													X		X		
106	Salomons, W. 1995. Environmental impact of metals derived from mining activities: Processes, predictions, prevention.	DB: Google Scholar Search Terms: small scale mining	Journal Article (Electronic)	Papua New Guinea, and Brazil					X												
46	Shandro, J.A., Veiga, M.M. and Chouinard, R. 2009. Reducing mercury pollution from artisanal gold mining in Munhena, Mozambique.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Mozambique			X		X	X							X	X		X	
100	Shen, L. and Andrews-Speed, P. 2001. Economic analysis of reform policies for small coal mines in China.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	China					X									X		X	
68	Shen, L. and Gunson, A.J. 2006. The role of artisanal and small-scale mining in China's economy.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	China														X	X		X

139	Siegel, S. and Veiga, M.M. 2009. Artisanal and small-scale mining as an extralegal economy: De Soto and the redefinition of “formalization”.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Uganda and sub-Saharan Africa				X	X	X					X			X
13	Sousa, R.N. and Veiga, M.M. 2009. Using performance indicators to evaluate an environmental education program in artisanal gold mining communities in the Brazilian Amazon.	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	Brazil (Amazon)			X		X							X		X
137	Spiegel, S.J. 2009. Resource policies and small-scale gold mining in Zimbabwe.	DB: Google Scholar Search Terms: small scale mining	Journal Article (Electronic)	Zimbabwe				X	X						X			X
56	Spiegel, S.J. 2007. Small-scale mining, rural subsistence and poverty in West Africa.	DB: Google Scholar Search Terms: small scale mining	Journal Article (Electronic)	West Africa						X					X			X
73	Spiegel, S.J. and Veiga, M.M. 2005. Building capacity in small-scale mining communities: health, ecosystem sustainability, and the Global Mercury Project.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Global		X	X	X	X	X		X			X	X		X
42	Spiegel, S.J., Yassi, A., Spiegel, J.M. and Veiga, M.M. 2006. Reducing mercury and responding to the	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)						X						X	X		X



	Angelica, R. Araujo, E.S. and Maurice, Y. 2006. The source and fate of sediment and mercury in the Tapajos River, Para, Brazilian Amazon: ground-and space-based evidence.	Search Terms: small scale mining	(Electronic)															
135	Tschakert, P. 2009. Recognizing and nurturing artisanal mining as a viable livelihood.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	sub-Saharan Africa				X	X	X				X	X			X
14	Tungalag, A., Tsolmon, R. and Bayartungalag, B. 2008. Land degradation analysis in the Ongi River basin.	DB: Google Scholar Search Terms: ninja mining	Journal Article (Electronic)	Mongolia	X				X									
11	Upton, C. 2008. Land rights, mining and resistance: New struggles on Mongolia's pastoral commons.	DB: Google Scholar Search Terms: ninja mining	Unpublished Material (Electronic)	Mongolia						X				X		X		X
83	Van Straaten, P. 2000. Human exposure to mercury due to small scale gold mining in northern Tanzania.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Tanzania					X									
76	van Straaten, P. 2000. Mercury contamination associated with small-scale gold mining in Tanzania and Zimbabwe.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Tanzania and Zimbabwe					X									
19	Veiga, M.M. and Baker, R.F. 2004.	DB: Google Scholar	Book Whole (Electronic)	Globally					X					X	X			X



	Protocols for environmental and health assessment of mercury released by artisanal and small-scale gold miners.	Search Terms: small scale mining in Mongolia																	
53	Veiga, M.M. and Hinton, J.J. 2002. Abandoned artisanal gold mines in the Brazillion Amazon: A legacy of mercury pollution.	DB: Google Scholar Search Terms: informal mining	Conference Proceedings (Electronic)	Brazil (Amazon)					X	X					X	X			X
96	Veiga, M.M., Scoble, M. and McAllister, M.L. 2000. Mining with communities.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Global					X	X					X	X	X		
134	Werthmann, K. 2009. Working in a boom-town: Female perspectives on gold-mining in Burkina Faso.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	Burkina Faso				X			X				X		X		
65	World Bank. 2007. Mongolia sources of growth; Country Economic Memorandum.	DB: Google Scholar Search Terms: ninja mining social determinants	Journal Article (Electronic)	Mongolia											X				X
69	Wright, T. 2007. State capacity in contemporary China: 'closing the pits and reducing coal production'.	DB: Google Scholar Search Terms: artisanal and small scale mining	Journal Article (Electronic)	China				X							X		X	X	
35	Wu, Y., Wang, S., Streets, D.G. Hao, J., Chan, M. and Jiang, J. 2006. Trends in anthropogenic mercury emissions	DB: Google Scholar Search Terms: artisanal mining	Journal Article (Electronic)	China					X							X			



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- Aspinall, C. and P. Eng (2001). "Small-scale mining in Indonesia." International Institute for Environment and Development, Mining Minerals and Sustainable Development Report **79**(Journal Article): 30.
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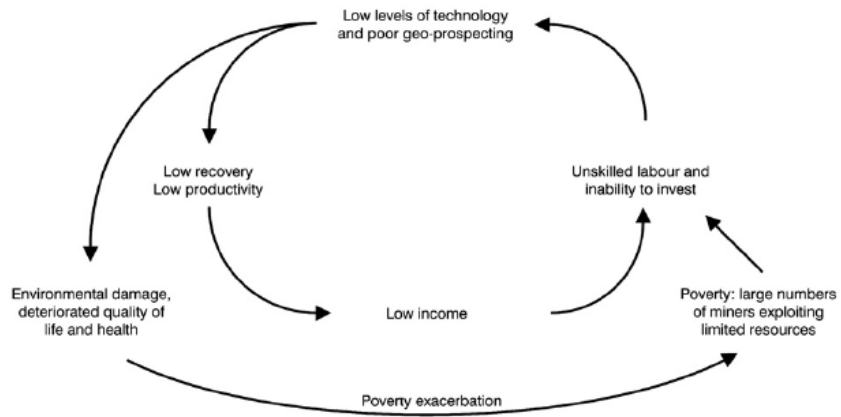
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## Appendix E: The perpetuating cycle of poverty



(Hilson, 2008)