

Avoiding Blindness to Health Status in Health Achievement and Health Inequality Measurement

Paul Makdissi*
University of Ottawa

Myra Yazbeck†
University of Queensland

April 2015

Abstract

This paper argues that health transfers from an individual at a lower rank in the health distribution to a person at a higher rank may decrease the concentration index if the former has a slightly higher income. The concentration index, being mainly focused on the socioeconomic dimension of health inequality, can produce such counter-intuitive results that overlooks the pure health inequality aversion of the planner. Building on Atkinson (1970), Yitzhaki (1983) and Wagstaff (2002), this paper presents a simple new class of health achievement and health inequality indices that overcomes the above mentioned problem.

Keywords: Health inequality, Health Achievement

JEL Codes: D63, I10

*Department of Economics, University of Ottawa, 55 Laurier E. (10125), Ottawa, Ontario, Canada, K1N 6N5;
Email: paul.makdissi@uottawa.ca

†School of Economics, 612- Colin Clark (39) Building, University of Queensland, Brisbane, QLD 4072, Australia;
Email: m.yazbeck@uq.edu.au

1 Introduction

A large body of the health inequality measurement literature is based on the accumulated knowledge in income inequality measurement. Early contributions to health inequality measurement by Le Grand (1989) and Le Grand and Rabin (1987) proposed the well known Gini coefficient as measure of *pure* health inequality (e.g., inequality in mortality). However, as the social planner may often be interested in the socioeconomic dimension of health inequalities (rather than pure health inequalities), the use of the concentration index is considered more appropriate (see Wagstaff, van Doorslaer and Paci, 1989; and Wagstaff, Paci and van Doorslaer, 1991). As a result, a large body of the literature is using the concentration index and it is now a widely accepted measure of socioeconomic health inequality.

The concentration index, as any other relative inequality measure, presents three well-known measurement problems. First, it does not capture variations in the average level of health of the population considered (for more details see Wagstaff, 2002). As a result, a policy that improves the average level of health, while keeping its relative distribution constant (i.e. an equal proportional increase in each health status), will be erroneously deemed a neutral policy. Second, when categorical variables are used (e.g., self-reported health status), the concentration index may be misleading. The ordinal nature of the variable at hand does not provide any information about the differences between health states. At best, it allows the analyst to rank individuals in terms of health status. This, in turn, makes the value of the concentration index somewhat arbitrary (Erreygers, 2006 and Zheng, 2008).¹ The last measurement problem is the *mirror problem* as pointed out by Clarke *et al.* (2002). It emphasizes the inconsistency in rankings produced by health attainment and those produced by health shortfalls. More specifically, the concentration index of health was shown to be equal to the concentration index of shortfall in health multiplied by the ratio of average shortfall in health to average health status (see Erreygers, 2009).

¹Most of the available health status information is given in the form of categorical variables.

To address the first problem, Wagstaff (2002) suggests the use of an achievement index that captures simultaneously the average level of health and the socioeconomic inequality of its distribution. As for the second problem, the literature offers three partial solutions, each of which is at a cost of capturing an incomplete picture of health inequalities. Allison and Foster (2004) propose a stochastic dominance approach to identify robust rankings of health distributions. Their approach offers a solution in the dimension of pure health inequality and forgoes the socioeconomic dimension. Zheng (2011) offers another solution by grouping individuals into socioeconomic ranks and imposing monotonicity of health in socioeconomic ranks. This approach overlooks the heterogeneity of the health statuses within each class. To address the same problem, Makdissi and Yazbeck (2014) focus on the width instead of the depth of health problems. Although their solution allows to capture the socioeconomic dimension of health inequality and the within class heterogeneity, it comes at the cost of overlooking the depth of health problems. Finally, to account for the third measurement problem, Erreygers (2009) has proposed a modified version of the concentration index. Unfortunately, as pointed out by Erreygers, this index is not an index of relative inequality.²

This paper contributes to the literature on the measurement of socioeconomic health inequalities by shedding light on a fourth measurement problem that has not yet been acknowledged by the literature on concentration indices. More specifically, its objective is to point out the indices' *blindness to health status* and present a method that allows the researcher to overcome it. By construction, health achievement indices or extended concentration indices react favorably when a health transfer is made from an individual at a lower rank in the health distribution to a person at a higher rank (regardless of the magnitude of the difference in their health status), provided that the former has a slightly higher income. Thus, this class of socioeconomic health inequality indices overlooks individual heterogeneity in the income-health relation. This is why it exhibits *blindness to health status*. It is important to note that although a unit health *per se* is not transferable, health

²Subsequently, Lambert and Zheng (2011) show that no index of relative inequality can really avoid this problem.

policies can influence individuals health level. As such, they act as if they were transferring a unit of health from one individual to another. We believe that it is important to acknowledge and solve this measurement problem as overlooking it makes the reliability of these indices questionable, especially if they are used with a counterfactual setting to conduct health policy evaluation. To address this issue, we first show that any index that belongs to Wagstaff’s class of health achievement indices or extended concentration indices exhibits *blindness to health status*. We then use the insight from Erreygers (2013) and construct Atkinsonian uni-dimensional indices of health inequality. We show that these Atkinsonian indices exhibit blindness to socioeconomic inequality but are sensitive to pure health inequality. We also compare both type of indices and propose a general class of indices that allows us to overcome *blindness to health status* by introducing an arbitrage between health status and socioeconomic status.³ We finally present an empirical illustration to provide evidence that this arbitrage may matter in practice and is not only a theoretical issue.

The remaining of the paper unfolds as follows. The next section presents the measurement framework on which our contribution will be based. In section 3, we will introduce a new class of health achievement and inequality indices: the Atkinson-Wagstaff class of health achievement and health inequality indices. Section 4 presents a brief empirical illustration using the Joint Canada/United States Surveys of Health 2004 and the Canadian Community Health Survey 2007-2008. The last section summarizes our results.

2 Review of Available Measures

The main aim of this paper is to provide a measurement framework that overcomes *blindness to health status* by capturing pure and socioeconomic health inequalities. To achieve this objective, we need to introduce an arbitrage between health status and socioeconomic status by combining two classes of indices: (a) Wagstaff health achievement and extended concentration indices and (b)

³Note that Erreygers (2013) dual Atkinson measure of socioeconomic inequality of health does not overcome this problem. As noted by Erreygers (2013), given the bi-linear nature of this measure, the marginal impact of a change in health is the same regardless of the initial health status.

Atkinson indices.

In what follows, we provide a description of the measurement framework of each of these indices. We first introduce Wagstaff's health achievement indices and extended concentration indices and discuss the possible issues that may result from the use of these indices by providing a numerical example. We then turn our attention to pure health inequality indices (i.e., the Gini indices and Atkinsonian indices) as they are a necessary ingredient in the solution that we propose. We also discuss the well known problems associated with these pure health inequality indices.

2.1 Wagstaff's Health Achievement Indices and Health Concentration Indices

The concentration index measures socioeconomic health inequality by ranking individuals according to their socioeconomic status (from lowest to highest) and then looking at the health distribution given this ranking. Let r_i , $i = 1$ to N , be the rank of individual i in a population of N individuals and h_i be the health status of individual i ., then Wagstaff's achievement indices (Wagstaff, 2002) can be written as follows:

$$A(\nu) = \sum_{i=1}^N \omega(r_i; \nu) h_i, \quad (1)$$

where

$$\omega(r_i; \nu) = \frac{(N - r_i + 1)^\nu - (N - r_i)^\nu}{N^\nu}, \quad \nu \geq 1. \quad (2)$$

For simplicity, it is assumed that health status h_i is a ratio-scale variable but one could use categorical variables by applying the count transformation proposed in Makdissi and Yazbeck (2014). Following Yitzhaki (1983), ν in equation (2) can be interpreted as a parameter of aversion to socioeconomic health inequality.⁴ If $\nu = 1$, there is no aversion to socioeconomic health inequality and $A(1)$ is simply the average health status, $\mu_h = \frac{1}{N} \sum_{i=1}^N h_i$. If $\nu > 1$, then the achievement index becomes averse to socioeconomic inequalities in health.

Wagstaff's class of extended concentration indices, $C(\nu)$, can be derived from achievement in-

⁴Note that Yitzhaki (1983) considers the context of income inequality.

dices defined in (1) using the following relationship:

$$C(\nu) = 1 - \frac{A(\nu)}{\mu_h}, \quad (3)$$

When $\nu = 2$, equation (3) represents the standard health concentration index that is widely used in the health inequality literature.

As argued earlier, these indices or any index that belongs to Wagstaff’s class of health achievement (/concentration) indices may increase (/decrease) when a health transfer is made from an individual at a lower rank in the health distribution to a person at a higher rank, provided that the former has a slightly higher income. This is why we say they are *blind to health status*. To provide a clear illustration of this measurement issue, we consider a situation where a policy maker (who has to choose between two alternative policies) is faced with the hypothetical population of 5 individuals as represented in Table 1.⁵ In this example, it is assumed that individual health status, h_i , is a ratio-scale variable that takes value between 0 and 1 (one may think of it as a HRQL index) where h^0 is health status before any policy intervention, h^1 is health status after implementing policy 1 and h^2 is health status after implementing policy 2. Assume that policy 1 can reallocate 0.01 unit of health from the individual at socioeconomic rank 4 who has a poor health status ($h_4^0 = 0.10$) to the individual at socioeconomic rank 2 who already has a good health status ($h_2^0 = 0.98$). The second policy, can reallocate the same 0.01 unit of health to the individual at socioeconomic rank 2 from the individual at socioeconomic rank 3 who has an initial health status of $h_3^0 = 0.88$.

Table 1: Hypothetical population

Socioeconomic rank	Initial health status h_i^0	Health status after policy 1 h_i^1	Health status after policy 2 h_i^2
1	0.90	0.90	0.90
2	0.98	0.99	0.99
3	0.88	0.88	0.87
4	0.10	0.09	0.10
5	0.75	0.75	0.75

⁵We acknowledge that a policy maker may want to rely on information collected using a counterfactual based approach. As we are looking into a measurement issue we will focus on an example with a before and after and abstract from the counterfactual dimension as it is beyond the scope of this paper.

Computing average health status (i.e., $A(1)$) before and after any of the two policy alternatives, yields the same value: $\mu_h^0 = \mu_h^1 = \mu_h^2 = 0.722$. However, computing the health achievement index $A(2)$ and the health concentration index $C(2)$ provide different rankings for these three scenarios. Health achievement and health concentration indices before and after the policy intervention are respectively $A_0(2) = 0.8164$ and $C_0(2) = -0.1307$ (before), $A_1(2) = 0.8180$ and $C_1(2) = -0.1330$ (after policy 1) and, $A_2(2) = 0.8172$ and $C_2(2) = -0.1319$ (after policy 2).⁶ Results shown in this hypothetical numerical example suggest that, if a policy maker's decision relies on health achievement indices and health concentration indices, then implementing any of these two policies leads to a social improvement. Furthermore, this example indicates that based on the information provided by the two indices, policy 1 is likely to be selected as the preferred policy. Such a conclusion is debatable as it is not clear that one would want to choose a policy that reallocates health resources by taking away from an individual who is in very poor health based on her relatively high socioeconomic status.

This numerical example raises two important questions: (1) why do Wagstaff health achievement indices and health concentration indices exhibit such a counter intuitive behavior? (2) is this counterintuitive behaviour observed in practice?

The answer to the first question resides in the structure of these indices as by construction they capture health inequality while relying exclusively on the socioeconomic statuses. More specifically, the impact of a marginal increase in the level of health status h_i on the achievement index $A(\nu)$ is independent of the original health status (i.e, before the hypothetical health transfer) and is decreasing in the socioeconomic rank r_i . This is why one has to be cautious when using such indices for health policy evaluation or population health monitoring as, in some cases, the results obtained can be misleading. To answer the second question, it is important to emphasize that in practice there is a lot of heterogeneity in health statuses by income ranks in survey data. There

⁶It is important to note that in our example, individuals located at the bottom of the socioeconomic distribution have higher health statuses.

are many instances where we observe pairs of individuals where one has a better health status but lower socioeconomic status than the other. For instance, a preliminary investigation of the sample in Joint Canada/United States Surveys of Health 2004 ⁷ comparing the highest quintile with the lowest quintile, reveals a positive health/income correlation between the two groups since the average HUI3 is 0.7892 in the low quintile and 0.9310 in the high quintile. However, as depicted in Figure 1, while the high income group has a more favorable HUI3 distribution, both densities overlap at many points. This suggests that having a pair of individuals such that one has a better health status but lower socioeconomic status than the other would not be an uncommon occurrence.

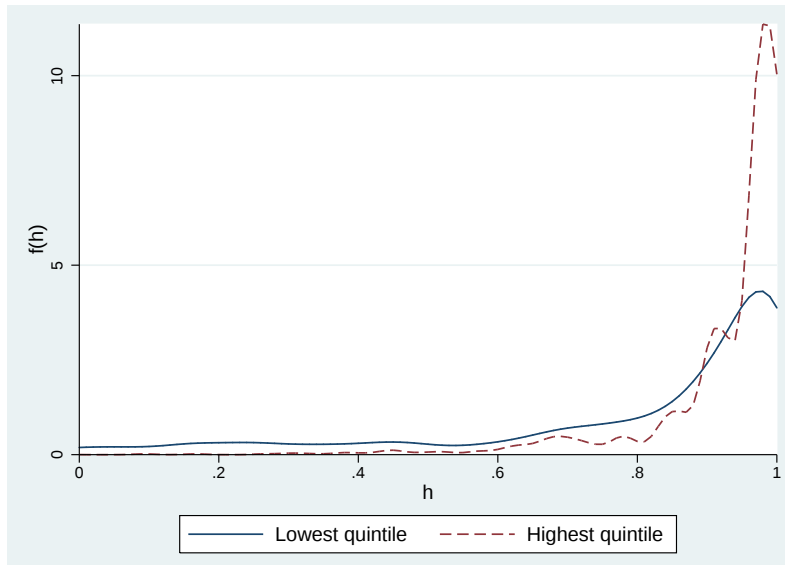


Figure 1: Density of HUI3

Given that the rank dependant structure of the concentration index may induce policy makers to erroneous decision making, it is crucial that we introduce some arbitrage between socioeconomic health inequality and pure health inequality. In order to do so, we need to combine these two types of indices (i.e., exploit the properties of socioeconomic health inequality indices and pure health inequality indices). The most natural candidate that allows for the introduction of pure health inequality is the Gini index as it is mathematically akin to concentration indices.⁸ While both

⁷More details on the survey are offered in the empirical section.

⁸Early health inequality literature (Le Grand, 1989 and Le Grand and Rabin, 1987) has heavily relied on the Gini

measures share a rank dependant structure, they differ in their ranking variable: the Gini index of health inequality uses ranks of individuals in the health distribution whereas the concentration index uses the socioeconomic ranks. As the combination of two different rank dependant indices based on different definitions of rank is not possible, we will rely Atkinsonian type of indices (instead of the Gini). These indices have the advantage of measuring pure health inequality without necessarily being rank dependant. In fact, they capture pure health inequality by imposing a concave social evaluation function of the health status.

2.2 Atkinsonian health achievement and pure health inequality indices

Atkinson's social welfare function is given by:

$$S^A(\varepsilon) = \begin{cases} \frac{1}{N} \sum_{i=1}^N \frac{h_i^{1-\varepsilon}}{1-\varepsilon} & \text{for } \varepsilon \neq 1 \\ \frac{1}{N} \sum_{i=1}^N \ln h_i & \text{for } \varepsilon = 1 \end{cases}, \quad (4)$$

where $\varepsilon \geq 0$ may be interpreted as a parameter of pure health inequality aversion. When $\varepsilon = 0$ then $S^A(0)$ is the average health status μ_h .

In the context of income inequality measurement, Atkinson (1970) defines the equally distributed equivalent income which is an adaptation of the certainty equivalent from economic theory of uncertainty. Following Erreygers (2013), we use this insight and define the equally distributed health status, $\xi^A(\varepsilon)$. This theoretical concept of equally distributed health status is the level of health such that, if everyone has this same level of health, the equal distribution of health lies on the same social indifference curve than the actual health distribution. We can interpret the equally distributed health status as the Atkinsonian pure health achievement index. Formally it is defined as:

$$\xi^A(\varepsilon) = \begin{cases} \left\{ \frac{1}{N} \sum_{i=1}^N h_i^{1-\varepsilon} \right\}^{\frac{1}{1-\varepsilon}} & \text{for } \varepsilon \neq 1 \\ e^{\frac{1}{N} \sum_{i=1}^N \ln h_i} & \text{for } \varepsilon = 1 \end{cases} \quad (5)$$

The Atkinson index of pure health inequality $I^A(\varepsilon)$ associated with the Atkinsonian pure health index to measure pure health inequality.

achievement index, $\xi^A(\varepsilon)$, is defined as:

$$I^A(\varepsilon) = 1 - \frac{\xi^A(\varepsilon)}{\mu_h}. \quad (6)$$

Table 2: Two hypothetical populations

Socioeconomic rank	Population <i>A</i> health statuses h_i^A	Population <i>B</i> health statuses h_i^B
1	0.10	0.98
2	0.75	0.90
3	0.88	0.88
4	0.90	0.75
5	0.98	0.10

Atkinsonian indices of pure health achievement and pure health inequality overlook the socioeconomic dimension of health inequality. To illustrate this point, we compute the Atkinsonian health achievement index and the corresponding health inequality index using the two hypothetical populations in Table 2. The computed indices are, $\xi_A^A(1) = \xi_B^A(1) = 0.5662$ and $I_A^A(1) = I_B^A(1) = 0.2157$ as any Atkinsonian index would yield the same numerical values for these two populations. This is the case because Atkinsonian indices are blind to the socioeconomic dimension of health inequality. As argued by Wagstaff, van Doorslaer and Paci (1989) and Wagstaff, Paci and van Doorslaer (1991), the analyst may be more interested in the socioeconomic dimension of health inequality than in pure health inequality. This is why they suggested the use of the health concentration index.

2.3 Comparing Wagstaff and Atkinson class of indices

In this section, we will use the numerical examples provided in the two earlier sections in order to compare Wagstaff and Atkinson class of indices.

If we consider the example in Table 3, the Atkinson indices indicate that policy 1 is not desirable since $\xi_0^A(1) = 0.5662$, $I_0^A(1) = 0.2157$, $\xi_1^A(1) = 0.5556$ and $I_1^A(1) = 0.2305$. This conclusion, while in contradiction with the one obtained by Wagstaff's class of indices, seems intuitive from an ethical perspective. Indeed, it is not appropriate to transfer health resources from someone who has a very poor health status to someone who is almost in perfect health (as would be suggested if we used a

Table 3: Hypothetical policies: Atkinson vs. Wagstaff

Socioeconomic rank	Initial status	After policy 1	After policy 2
Achievement			
Atkinson $\xi^A(1)$	0.5662	0.5556	0.5661
Wagstaff $A(2)$	0.8164	0.8180	0.8172
Inequality			
Atkinson $I^A(1)$	0.2157	0.2305	0.2159
Wagstaff $C(2)$	-0.1307	-0.1330	-0.1319

concentration index).

If we were to rely on Wagstaff's health achievement index $A(2)$ and the health concentration index $C(2)$ and revisit Table 2, the obtained results as shown in Table 4 would indicate that the health distribution of population B is preferred to the health distribution of population A . This is the case because $A_B(2) = 0.8748 > A_A(2) = 0.5692$ and $C_B(2) = -0.2116 < C_A(2) = 0.2116$. These results are in contradiction with the results obtained when using Atkinson indices where $\xi_B^A(1) = \xi_A^A(1)$ and $I_B^A(1) = I_A^A(1)$.

Table 4: Two hypothetical populations: Atkinson vs. Wagstaff

Index	Population A	Population B
Achievement		
Atkinson $\xi^A(1)$	0.5662	0.5662
Wagstaff $A(2)$	0.5692	0.8748
Inequality		
Atkinson $I^A(1)$	0.2157	0.2157
Wagstaff $C(2)$	0.2116	-0.2116

This lack of congruence between the conclusions reached when using Atkinson indices and those reached when using Wagstaff indices arises for two reasons. First, Wagstaff health achievement indices and health concentration indices focus on the socioeconomic dimensions of health inequalities. Thus, they are totally blind to pure health inequalities. Second, Atkinson indices focus on pure health inequality and are therefore blind to socioeconomic status. The purpose of the next section will be to propose a class of indices that captures pure health inequality aversion in addition to socioeconomic health inequality aversion.

3 Atkinson-Wagstaff Health Achievement and Health Inequality Indices

In this section, we propose to combine both Wagstaff and Atkinson indices to overcome *blindness to health status*. In doing so, this paper is closely related to the work of Araar and Duclos (2003). While Araar and Duclos (2003) combined Gini and Atkinson indices in the context of measurement of income inequality, this paper proposes a novel approach as far as the dimensions of wellbeing considered. Unlike Araar and Duclos (2003), we use ranks that are obtained in another dimension (i.e., income) than the variable in which inequality is measured (i.e., health) and propose a “generalized” form of Achievement and its corresponding version of health inequality indices.⁹ This new “generalized” version of health achievement indices (and its corresponding version of health inequality indices) captures both pure and socioeconomic health inequality aversion. The social preference associated with this class of indices will take the following form:

$$S(\nu, \varepsilon) = \begin{cases} \sum_{i=1}^N \omega(r_i; \nu) \frac{h_i^{1-\varepsilon}}{1-\varepsilon} & \text{for } \nu \geq 1, \varepsilon \geq 0 \text{ and } \varepsilon \neq 1 \\ \sum_{i=1}^N \omega(r_i; \nu) \ln h_i & \text{for } \nu \geq 1, \varepsilon = 1 \end{cases} \quad (7)$$

where $\omega(r_i; \nu)$ is given by equation (2). The corresponding equally distributed health status is given by:

$$\xi(\nu, \varepsilon) = \begin{cases} \left\{ \sum_{i=1}^N \omega(r_i; \nu) h_i^{1-\varepsilon} \right\}^{\frac{1}{1-\varepsilon}} & \text{for } \nu \geq 1, \varepsilon \geq 0 \text{ and } \varepsilon \neq 1 \\ e^{\sum_{i=1}^N \omega(r_i; \nu) \ln h_i} & \text{for } \nu \geq 1, \varepsilon = 1 \end{cases} \quad (8)$$

and the class of health inequality index takes the following form:

$$I(\nu, \varepsilon) = 1 - \frac{\xi(\nu, \varepsilon)}{\mu_h}. \quad (9)$$

As mentioned earlier, we can interpret ν as a parameter of socioeconomic health inequality aversion (Yitzhaki, 1983), and we can interpret ε as a parameter of pure health inequality aversion (Atkinson, 1970). When ε is set to zero, we obtain Wagstaff’s class of achievement and extended concentration indices. Further, when ε is set to zero and ν is set to two, then $I(2, 0)$ is the widely used health

⁹Note that Araar and Duclos consider a special case of Berrebi and Silber (1981). Lambert and Zheng (2011) have considered this latter class of indices in the measurement of pure health inequality.

concentration index. When ν is set to one, we obtain the Atkinsonian class of achievement and inequality indices. If $\nu \neq 1$ and $\varepsilon \neq 0$, the index displays aversion to both pure and socioeconomic health inequality. An analyst or policy maker who wishes to account for health status and socioeconomic status simultaneously, should choose a positive value for ε and a value for ν that exceeds one.

Table 5: Two hypothetical populations: Atkinson-Wagstaff indices

Index	Population <i>A</i>	Population <i>B</i>
Achievement $\xi(2, 1)$	0.3873	0.8278
Inequality $I(2, 1)$	0.4635	-0.1466

If we consider the example provided in Table 2 and compute the proposed indices then we obtain: $\xi_A(2, 1) = 0.3873$, $I_A(2, 1) = 0.4635$, (for distribution A) and $\xi_B(2, 1) = 0.8278$, $I_B(2, 1) = -0.1466$ (for distribution B). Given these results, one can say that population *B* displays higher health achievement and lower health inequality than population *A*. How do results obtained from these indices compare to those obtained by a standard Wagstaff and standard Atkinson class of indices presented in Table 4? Results obtained from Atkinson class of indices showed that distributions in population A and population B were similar, whereas Wagstaff class of indices revealed that distribution in population B was preferred. Thus, this example shows how the socioeconomic dimension of health inequality that is missed by an Atkinson class of indices is now captured.

Table 6: Hypothetical policies: Atkinson-Wagstaff indices

Socioeconomic rank	Initial status	After policy 1	After policy 2
Achievement $\xi(2, 1)$	0.6998	0.6930	0.7002
Inequality $I(2, 1)$	0.0308	0.0402	0.0302

Table 6 presents the Atkinson-Wagstaff indices computed using information on the two hypothetical policies provided in Table 1. It is clear that the rankings of the two policies are different

from the ranking obtained by the Wagstaff and the Atkinsonian indices discussed earlier in Table 3. Following the implementation of the first policy, health achievement decreases and health inequality increases. This ranking of policy 1 is compatible with the Atkinsonian ranking. After policy 2, health achievement increases and health inequality decreases. This ranking is compatible with the Wagstaff ranking. The numerical example discussed above shows that Wagstaff-Atkinson indices allows us to introduce an arbitrage between socioeconomic status and health status, as they account for both pure and socioeconomic health inequality aversion. It is important to note that this new index still reacts favorably to a redistribution from an individual with a slightly lower health (i.e., when the difference in health status is small) but higher socioeconomic status to another with a *slightly* better health but lower socioeconomic status (i.e., from individual at socioeconomic rank 3 to individual at socioeconomic rank 2). However, if the difference in health status is large (e.g., individual at socioeconomic rank 4 compared individual at socioeconomic rank 2), the index reacts negatively to a similar transfer even if the individual with the poor health status has a higher socioeconomic status. As such, the index exhibits an arbitrage between socioeconomic rank and health.

4 Empirical Illustration

In this section, we present a brief illustration using the parametric class of indices introduced in the previous section. We provide empirical evidence that this parametric class may, in some cases, rank distributions differently when compared to rankings given by Wagstaff and Atkinsonian classes of indices separately. In a first step, we will compare health inequalities between the U.S. and Canada. We show how the health achievement and the health inequality rankings between Canada and the U.S. seem robust to a change in socioeconomic or pure health inequality aversion. In a second step, we focus on health inequalities within Canada, more precisely in the Greater Montréal region, and divide the extended Montréal region into four administrative subregions. This allows us to

illustrate how a change in socioeconomic and/or pure health inequality aversion can change the ranking between some of these subregions once the indices' *blindness to health status* is accounted for.

4.1 Comparing health distribution in the U.S. and Canada

To compare health achievement and health inequality in Canada and in the U.S., we use the Joint Canada/United States Surveys of Health (JCUSH) 2004. This survey entails 8,688 observations of which 3,505 are Canadian residents and 5,183 are U.S. residents. It covers individuals between the age of 18 and 85 years and information about their clinical condition as well as their demographic characteristics and their socioeconomic status. We use information on household income to infer the socioeconomic rank of individuals. In this paper, an individual health status is based on the Health Utility Index Mark 3 (HUI3), which covers eight attributes: vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain. Each attribute has five or six levels and each attribute utility score ranges from 0 (for instance blind for vision) to 1 (perfect vision). The HUI3 ranges from -0.36 to 1, the negative values are there to express a state that is worse than death whereas values of 0 reflect death.

Table 7: Indices for Canada and the U.S.A.

	$\xi(\nu, \varepsilon = 1)$			$I(\nu, \varepsilon = 1)$		
	$\nu = 1$	$\nu = 2$	$\nu = 3$	$\nu = 1$	$\nu = 2$	$\nu = 3$
Canada	0.810074	0.759429	0.729261	0.071116	0.129189	0.163782
USA	0.789987	0.725244	0.683903	0.084625	0.159644	0.207547
	$\xi(\nu = 2, \varepsilon)$			$I(\nu = 2, \varepsilon)$		
	$\varepsilon = 0$	$\varepsilon = 1$	$\varepsilon = 2$	$\varepsilon = 0$	$\varepsilon = 1$	$\varepsilon = 2$
Canada	0.841327	0.759429	0.349726	0.03528	0.129189	0.598981
USA	0.825597	0.725244	0.284505	0.043362	0.159644	0.670338

Looking at Table 7 we notice that Canada has higher health achievement indices and lower health inequality indices and that these results are robust to all assigned values of ν and ε . More specifically, these rankings are all similar to Wagstaff's achievement index $\xi(2, 0)$ and to the standard health

concentration index $I(2, 0)$.¹⁰ This means that, in this particular case, all the estimated indices would have ranked Canada above the U.S regardless of whether they are *blind to health status*. Thus, at this point, the added value of using our class of indices remains mainly theoretical as it is not yet empirically verified. While one might be inclined to ignore this issue, we will show in through the next illustration that *blindness to health status* can in fact occur and could mislead policy makers.

4.2 Comparing health distribution within the Greater Montréal region

We next concentrate on health achievement and inequality within the Greater Montréal region in Canada and use the Canadian Community Health Survey (CCHS) 2007-2008. This survey is cross-sectional, it covers 131,061 Canadians aged 12 and above. It provides information related to their health status, their clinical conditions, their health care utilization as well as health determinants. We have 8,572 observations for the Greater Montréal region. As in the previous example, we use information on household income to infer the socioeconomic rank of the individual and the HUI3 as indicator of the individual health status. Four subregions are considered: Montréal (located on an island in the St-Lawrence river), Laval (located on an island adjacent to Montréal), Montérégie (suburbs located on the south shore of the river) and Laurentides (suburbs located on its north shore).

The computed health achievement and inequality indices reported in Table 8 indicate the health achievement and health inequality rankings for the Greater Montréal region varies when different values of pure and socioeconomic health aversion parameters are considered. Let us focus on the upper panel of Table 8 and start by looking at the health inequality index, $I(1, 1)$. When $\nu = 1$, there is no socioeconomic health inequality aversion. We are therefore looking at Atkinsonian indices. The corresponding inequality ranking is: Laval, Montérégie, Laurentides and Montréal. If we introduce

¹⁰We take the case where $\nu = 2$ since it is associated with the standard health concentration index. We acknowledge that Wagstaff's class of indices allows for ν to take any value larger than one.

Table 8: Indices for the Greater Montréal region.

	$\xi(\nu, \varepsilon = 1)$			$I(\nu, \varepsilon = 1)$		
	$\nu = 1$	$\nu = 2$	$\nu = 3$	$\nu = 1$	$\nu = 2$	$\nu = 3$
Montréal	0.834493	0.796713	0.775435	0.058153	0.100793	0.124808
Montréal	0.846776	0.810485	0.7902	0.048085	0.088882	0.111686
Laval	0.851641	0.819217	0.80155	0.045213	0.081564	0.10137
Laurentides	0.850999	0.812145	0.789155	0.04811	0.09157	0.117285

	$\xi(\nu = 2, \varepsilon)$			$I(\nu = 2, \varepsilon)$		
	$\varepsilon = 0$	$\varepsilon = 1$	$\varepsilon = 2$	$\varepsilon = 0$	$\varepsilon = 1$	$\varepsilon = 2$
Montréal	0.866472	0.796713	0.37618	0.022059	0.100793	0.575426
Montréal	0.867005	0.810485	0.486994	0.025344	0.088882	0.452539
Laval	0.873196	0.819217	0.49288	0.021047	0.081564	0.447425
Laurentides	0.869551	0.812145	0.309894	0.027358	0.09157	0.653367

socioeconomic health inequality aversion (i.e. we set $\nu > 1$), the inequality ranking for this particular example remains unchanged. As for the health achievement index, imposing no socioeconomic health inequality aversion, $\xi(1, 1)$, results in the following ranking: Laval, Laurentides, Montréal and Montréal. Increasing ν to 2 does not change this ranking. However, increasing socioeconomic health inequality parameter ν to 3 changes the ranking to: Laval, Montréal, Laurentides and Montréal. While these results may suggest ranking inconsistency, they are in line with Wagstaff's (2002) argument. Indeed, accounting for average health status and changing the level of socioeconomic health inequality aversion can modify rankings provided by a health inequality index.

Considering the lower panel of the table, it is important to keep in mind that when $\varepsilon = 0$, we have the Wagstaff class of health achievement and health concentration indices (i.e., no aversion to pure health inequality). Once we introduce pure health inequality aversion (i.e., $\varepsilon > 0$) and compute indices à la Atkinson-Wagstaff, it is clear that rankings provided by $\xi(2, \varepsilon = 0)$ and $I(2, \varepsilon = 0)$ change in most of the cases. It reflects the impact of accounting for pure health inequality aversion when analyzing socioeconomic health inequalities. This specific empirical example provides support for the relevance of our theoretical argument and suggests that it goes beyond the hypothetical example provided earlier. More specifically, if we consider health inequality indices $I(2, \varepsilon)$ and analyze how the rankings produced by these indices change with a variation of the parameter ε ,

then, for $\varepsilon = 0$, the subregions are ranked as follows (from lowest to highest inequality): Laval, Montréal, Montérégie and Laurentides. Note that for this ranking, only socioeconomic health inequality aversion is taken into account since the social planner has no pure health inequality aversion (i.e. $\varepsilon = 0$). If we introduce pure health inequality aversion by increasing ε to 1, the ranking changes to: Laval, Montérégie, Laurentides and Montréal. Further, increasing pure health inequality to $\varepsilon = 2$ changes the ranking to: Laval, Montérégie, Montréal and Laurentides. As for the health achievement indices, if we consider the case where there are no pure health inequality aversion, $\xi(2, \varepsilon = 0)$, the ranking (from highest to lowest achievement) is: Laval, Laurentides, Montérégie and Montréal. The ranking stays the same when we increase ε to 1 but changes to: Laval, Montérégie, Montréal and Laurentides, when we consider $\varepsilon = 2$. The variation in rankings resulting from the use of different values for ε provides, once again, an empirical evidence of the indices' *blindness to health status* and thus highlights the relevance of the theoretical argument and the importance of addressing this measurement issue.

5 Conclusion

In this paper, we point out that socioeconomic health inequality indices may exhibit *blindness to health status*. In this case, misleading information on a policy's impact on socioeconomic health inequalities may emerge. Socioeconomic health inequality indices have a rank dependant structure. More specifically, the sorting variable is the socioeconomic rank. This is why the information arising from the rank in the health distribution is usually muted allowing thus for *blindness to health status* to occur. To introduce the information obtained from the rank in the health distribution in the Wagstaff class of indices, we propose a new class of indices that combines Wagstaff and Atkinson indices. This new class of indices accounts for *blindness to health status* by allowing for dependence between health status and socioeconomic rank to be present in the underlying social welfare function. To illustrate how the proposed class of indices may produce rankings that are

different from those obtained by a standard Wagstaff class of achievement and inequality indices, we provide two empirical illustrations. In the first illustration, our proposed class of indices and Wagstaff class of achievement and inequality indices provide consistent rankings. However, in the second illustration the results obtained show that eliminating *blindness to health status* may change the rankings of health distributions. Our empirical illustration seems to corroborate our theoretical argument regarding the indices *blindness to health status*. As a result it highlights the importance of using the proposed class of indices when measuring socioeconomic health inequalities. It is important to note that the proposed class of indices still reacts favourably to a redistribution from an individual with a slightly lower health but higher socioeconomic status to another with a slightly better health but lower socioeconomic status. However, if the difference in health status is large, the index will react negatively to a similar transfer even if the person with the lower health status has a high socioeconomic status.

References

- [1] Allison, R.A. and J.E. Foster (2004), Measuring health inequality using qualitative data, *Journal of Health Economics*, 23, 505-524.
- [2] Araar, A. and J.Y. Duclos (2003), An Atkinson-Gini family of social evaluation functions, *Economics Bulletin*, 3(19), 1-16.
- [3] Atkinson, A.B. (1970), On the measurement of inequality, *Journal of Economic Theory*, 2, 244-263.
- [4] Berrebi and Silber (1981), Weighting income ranks and levels: A Multiple-Parameter Generalization For Absolute and Relative Inequality Indices, *Economics Letters*, 7, 391-397.
- [5] Clarke, P.M., U.G. Gerdtham, M. Johannesson, K. Borgefors and L. Smith (2002), On the measurement of relative and absolute income-related health inequality. *Social Science and Medicine*,

55, 19231728.

- [6] Erreygers, G. (2006), Beyond the Health Concentration Index: An Atkinson Alternative for the Measurement of the Socioeconomic Inequality of Health, University of Antwerp, Faculty of Applied Economics, Research Paper 2006-029.
- [7] Erreygers, G. (2009), Correcting the concentration index, *Journal of Health Economics*, 28, 504-515.
- [8] Erreygers, G. (2013), A dual Atkinson measure of socioeconomic inequality of health, *Health Economics*, 22, 466-479.
- [9] Fishburn, P.C. and R.D. Willig (1984), Transfer principles in income redistribution, *Journal of Public Economics*, 25, 323-328.
- [10] Kolm, J.-C. (1976), Unequal Inequalities I, *Journal of Economic Theory*, 12, 416-442.
- [11] Lambert and Zheng (2011), On the consistent measurement of attainment and shortfall inequality, *Journal of Health Economics*, 30, 214-219.
- [12] Le Grand, J. (1989), An international comparison of distributions of ages-at-death, in Fox, J. (Ed.), *Health Inequalities in European Countries*, Gower, Aldershot.
- [13] Le Grand, J. and M. Rabin (1986), Trends in British health inequality 1931-1983, in Culyer, A.J. and B. Jonsson (Eds.), *Public and Private Health Services*, Blackwell, Oxford.
- [14] Makdissi, P. and M. Yazbeck (2014), Measuring Socioeconomic Health Inequalities in Presence of Multiple Categorical Information, *Journal of Health Economics*, 34, 84-95.
- [15] Wagstaff, A. (2002), Inequality aversion, health inequalities and health achievement, *Journal of Health Economics*, 21, 627-641.

- [16] Wagstaff, A., , P. Paci and E. van Doorslaer (1991), On the measurement of inequalities in health, *Social Science and Medicine*, 33, 545-557.
- [17] Wagstaff, A., E. van Doorslaer and P. Paci (1989), Equity in the finance and delivery of health care: some tentative cross-country comparisons, *Oxford Review of Economic Policy*, 5, 89-112.
- [18] Yitzhaki, S. (1983), On an extension of the Gini index, *International Economic Review*, 24, 617-628.
- [19] Zheng, B. (2008), Measuring Inequality with Ordinal Data: A Note, *Research on Economic Inequality*, 16, 177-188.
- [20] Zheng, B. (2011), A new approach to measure socioeconomic inequality in health, *Journal of Economic Inequality*, 9, 555-577.