Health disparities between racial groups in South Africa: a decomposition analysis

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Introduction

A large number of theoretical and empirical papers have recently been devoted to the measurement and the explanation of health and social health inequality [Wagstaff *et al.* (1991), Kakwani *et al.* (1997), Wagstaff et van Doorslaer (2002), Pradhan et *al.* (2003)]. This question is all the more crucial in the case of South Africa especially concerning health disparities between racial groups. Indeed, since the colonisation of the country, a selective restriction of economical, political, social and curative rights and an institutional segregation have been implemented. It created discriminations, differences on poverty levels, on health care supply, and education between racial groups. Different racial groups have thus been facing very different health risks factors.

Since 1990, Apartheid has been officially taken over by a multiracial democracy confronted to poverty and inequality. In 1994, the Government of National Unity defined five key human development priorities: employment, housing, education, nutrition and health. Five programs have thus been implemented to combine reconstruction with development and growth, and also redistribution with democratisation. Health reforms aimed at an entire reorganisation of the health care system, based on increased community participation and focussed on the promotion of primary health care. Today, a decade after South Africa democratisation, several human development objectives still remain to be achieved, and discrimination persists. Indeed, it has been shown that racial and economical segregation still have significant discriminatory

impacts on under-five mortality, anthropometrical measures and demand for curative health care [Charasse (1999)]. In South Africa, racial group still seems to be a strong determinant of individual income and educational attainment, individual and community health care supply, but also of individual health care demand and of the quality of medical treatment.

The objectives of this paper are twofold. First, we intend to measure health disparities between racial groups in 1999 using a self-assessed health indicator. This indicator is not only a complex human judgement on current health of the individual, but also a representation of the history of his/her family, as well as an indication on life expectancy and potential health problems [Idler and Benyamini (1997)]. Second, we propose a decomposition of observed health disparities between racial groups using the Oaxaca-Blinder decomposition method [Oaxaca (1973), Blinder (1973]. Our aim is to isolate what is due to structural socio-economical differences between racial groups (what we will name in the following "indirect segregation"), and what is due to a permanent racial segregation phenomenon on access to health care and type/quality of treatment ("direct segregation" called also discrimination).

Our work is based on the 1999 October Household Survey[1] covering more than 100 000 individuals, which provides valuable information on health and structural explanatory variables. The paper is organized as follows. Section 1 presents the background of health, segregation and discrimination in South Africa. Section 2 presents the data used and discusses the indicator chosen for health. Section 3 presents the decomposition method applied to the data. Section 4 discusses estimation results and section 5 presents our decomposition results and discusses the segregation issue taken into account of the reporting bias problem associated with self-assessed health indicator

1. Segregation, discrimination and health

This paper is part of a research conducted on health and discriminations in South Africa. Initially, in this country, racial segregation, Apartheid, was only serving Whites' interests. Cultural pluralism, first officially aimed at creating a development process respective of the African culture, created racism and cultural imperialism [Giliomee (1993)]. Until the 70's, white superiority enabled prejudices and discrimination. Afterwards, the principle of « separation in equality » conducted to systematic racial segmentation and to a positive apartheid based on a separated development of potentially equal nations. But, racism, discriminations and human

[1] Statistics South Africa; October Household Survey (South Africa), 1999; Pretoria, South Africa: Statistics South Africa (producer); Pretoria : South African Data Archive (distributor), 2001. http://www.nrf.ac.za/sada. SADA 0114.

dignity shortfalls were real. South Africans were separated and not equally treated on a racial basis. The policies of Apartheid and the whole social system in South Africa have created institutional and structural discriminations and large disparities between racial groups[2] in terms of socio-economic status, employment, education, housing and health services. Africans were the most discriminated group.

On the health care side, the political and institutional development of the country created a fragmented public health care system[3] (predominantly focussed on hospital care) with an inequitable access on racial and geographical basis. At the same time, a private sector with fee for service method of reimbursement and better quality of care permits segregation by income to join official segregation by race. Resources, health care supply and quality of care have been distributed along racial, economical and geographical basis in the public and private sectors.

Citizens could be under and/or overserviced at the same time by an health care system where basic needs were omitted and economical and racial discrimination coexisted. Then, at the end of Apartheid, disparities between racial groups were huge. In 1993, the average monthly income of an african household is 679 rands, seven times less than for a white household. It was estimated that[4] 61% of Africans, 38% of Coloureds, 5% of Indians and 1% of Whites fall below the poverty line. In South Africa, Whites enjoyed better socio-economic and sanitary environment (for example 99.9 per cent of them are connected to piped water) and better access to a high quality of health care services. Unequal access to health care services and bad socio-economic conditions induced a large burden of disease amongst Africans, especially infectious and parasitary diseases. McIntyre *et al.* (1995) reported that social diseases conducted seven times more to death amongst Africans (14%) than among Whites (2%) and cardio-vasculary diseases induced 40 per cent of Whites' deaths against 12 per cent of Africans' deaths. On the 27th of April 1994, the new South Africa was born. At this date, the first multiracial government was democratically elected. A new health ministry was in place and the first African Minister of Health was designated, Nkosazana Dlamini Zuma. She was in charge of elaborating a unitary and egalitarian health care system for all South-Africans. Between 1994 and 1999 progress have been made in overcoming the apartheid legacy. The first reforms, in April 1994, concerned the disadvantaged groups (women

[2] The term 'Black' refers collectively to all radically oppressed groups and not just to 'Africans'. However, since the social, economic and political institutions in South Africa were structured along legally defined racial categories which divide Blacks into 'Indians', 'Coloured' and 'Africans', their daily experience and consequent health patterns couldn't be described without recourse to such racial terminology. Their use in this paper, however, does not imply their legitimacy. Note that, population group classification was based on a legal definition, but it is now based on self-perceptions and self-classification. An African is someone who classifies him/herself as such.

[3] The health system had been fragmented into not contiguous National, Coloured, Indian and White "own affairs", four provincial and 10 homeland health departments.

and children under six) to be extended in 1996. Since April 1996, free basic curative health care is available in the day hospitals and the public clinics for all. Buch (2001) noticed that achievements in the health sector from 1994 to 2000 include also the establishment of a unitary health system with a single national department and nine provincial health departments, the removal of institutional racism, the upgrading of many clinics and health centres and the building of 500 new ones in under-served communities, progress in the establishment of a District Health System, a community service for newly qualified doctors especially in the poorest part of the country, the contract with Cuban doctors to improve medical care in under-served areas, a massive primary school nutrition programme, the improvement of vaccination, or the launch of Patient's Charter to serve as a benchmark of how patients could expect to be treated. Furthermore, in 1996, negative discrimination was officially taken out of the new South African constitution. Health became a fundamental right. Moreover, this principle of legal equality doesn't mean effective equity, justice or immediate disappearance of discriminations.

The fundamental questions are now : What are the explanations of health disparities between racial groups? Is racial group still a strong direct determinant of health status showing a racial discrimination phenomenon and/or is it an indirect one acting through the social, economical or medical environment associated with each group?

2. Data

The survey

We use the 1999 October Household Survey (1999 OHS). It's an annual cross-sectional survey[5] based on a probability sample of a large number. The OHS of 1999 was drawn from a master sample. The sampling procedure (of the Primary Sampling Units PSU and of the households) for the master sample involved explicit stratification by province and within each province, by urban/rural areas. Almost 30 000 households were visited as ultimate sampling units in 1999. The 1999 OHS, in common with 1997 and 1998, was weighted to reflect estimates of the population size based on the population census of October 1996, as adjusted by a post-enumeration survey, using post-stratification by province, gender and five-year interval age groups.

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[4] Statistics South Africa. Mid year estimates 1999. Statistical Release P0302. (Available at http://www.statssa.gov.za/Statistical_releases/Statistical_releases.htm.)

[5] The CD-rom of the OHSs could be ordered at User Enquiries, Statistics South Africa, electronic mail : info@statssa.pwv.gov.za or at the South African Data Archive, National Research Foundation, electronic mail : sada@nrf.ac.za, web site : http://www.nrf.ac.za/sada.

All OHSs cover a range of development indicators regarding individuals or households. For example, access to the labour market, access to housing, main source of water, toilet facilities, health services utilisation are examined. Data do not show a slight improvement or deterioration of the socio-economic environment of South Africans [Hirschowitz (2001)].

The indicator of health

Theoretically and empirically, there are different measures of health status which may be applied to the study of health disparities between groups of population. Measuring health status is complex due to the multidimensional nature of health and the lack of objective ordering except in the case of life and death or when pathologies appeared. Empirical papers on health inequality, health production, health care demand could use individual declared mortality[6]. But, self-evaluations of health status and morbidity are often preferred because they are very informative and are now routinely collected in households surveys. In this paper, we use an indicator of self-assessed health (SAH). SAH is a simple subjective measure of health that provide an ordinal ranking of perceived health status. In the 1999 OHS, every person in the household was asked to describe her health as very poor, poor, average, good, excellent. This indicator is used for the following reasons.

At first, this indicator indicates how equally or unequally health is distributed in the population of South Africa. Table 1 shows that there are intra-South Africa differences of SAH in 1999. There is a marked difference between Whites and Africans in terms of SAH (50.84% of Africans considered having an excellent health compared to 57.14% of Whites).

Table 1 : Self-assessment of health status by racial group in 1999.

Level of health	African	White
Very Poor	0.80 %	0.27%
Poor	4.57 %	2.13%
Average	8.01 %	6.20%
Good	35.78 %	34.31 %
Excellent	50.84 %	57.14 %
Number of people	82601	7876

Source : OHS 1999

[6] Strauss and Thomas (1995) assessed that declared mortality systematically under-estimates real mortality especially when the respondent has a low social status.

Secondly, on the basis of several epidemiological, economical or sociological surveys conducted in developed countries, Idler and Benyamini (1997) showed that this indicator is not only a complex human judgement on current health of the individual, but also a representation of the history of his/her family, as well as a prediction of life expectancy and potential health problems. They conclude that "self-ratings represent a source of very valuable data on health status. They assess a currently unknown array of perceptions and weight them according to equally unknown and varying values and preferences, provide the respondents' views of global health status in a way than nothing else can". Furthermore, the predictive power of SAH does not appear to vary across socio economic groups [Burström and Fredlund (2001)]. Flylkesnes and Helge Forde (1991), Van Doorslaer et al. (2000) pointed SAH is also an independent predictor of number of complaints and medications and is among the best predictors of patient-initiated visits.

However, a polemic exists on the measure and use of SAH. Researchers noted that SAH is often associated to a reporting behaviour bias. In fact, it means that the mapping of "true" health into SAH categories may vary with respondent characteristics. This source of measurement error has been termed 'state-dependent reporting bias" [Kerkhofs and Lindeboom (1995)], "scale of reference" bias [Groot (2000)] and "response category cut-point shift" [Murray *et al.* (2001)]. This occurs if sub-groups of the population use systematically different cut points dependent of cultural, economical, social or gender expectations for health. Consequently, one could observe that education of head of the household, culture, medical and sanitary information of populations, social norm of disease[7] can induce systematic reporting bias of SAH. These biases can also be linked to health services accessibility and availability, to the use of health system, to individual income [Strauss and Thomas (1998)], to employment status. In South Africa, social and economic discriminations between racial groups have induced a number of people to hide their disease [Charasse (1999)]. Iburg *et al.* (2001) have shown using data from the US National Health and Nutrition Examination Survey III that the cut points (on the question of self-reported difficulty with regard to walking for a quarter of a mile) for a black, poor, less educated, older female were below those for a white, rich, well educated, younger male.

As Lindeboom and van Doorslaer (2003) noted, these biases may have important implications for the measurement or the explanations of disparities in health. In section 4 and 5, it is exactly what we are dealing with and trying to overcome.

3. The methodology

Using the 1999 OHS dataset, we try to explain health disparities between racial groups in South Africa and to isolate a potential effect of racial discrimination. Several interesting papers have been published to measure and analyse pure or socio-economic inequalities in the health sector [Wagstaff *et al.* (1991), Kakwani *et al.* (1997), Wagstaff *et al.* (2001), Wagstaff and van Doorslaer (2002)]. The most traditional approach has been to think of differences in health status according to an individual's income or economic standing [Wagstaff (2000), Makinen *et al.* (2000), Castro-Leal *et al.* (2000)]. Gender inequalities in health status have also received a great deal of attention [Arber (1997), Macintyre *et al.* (1996), Montoya Diaz (2002)] and ethnic inequalities in health have also been of particular concern in recent years. Nevertheless, the decomposition of racial disparities remain rare and difficult.

We use an improved form of the Oaxaca-Blinder decomposition method [Oaxaca (1973), Blinder (1973]. Our aim is here to decompose the two pathways used by segregation to operate on health : what is due to structural socio-economical differences between racial groups (indirect segregation effect or explained components), and what is due to a discrimination phenomenon on access to health care and type/quality of treatment (direct segregation effect or unexplained components). We propose counterfactual situations corresponding to health that would be observed for Africans had they been faced with the "health demand process" observed for whites and reciprocally. By "health demand process" we understand the mechanisms through which individuals health is affected by socio-economic characteristics. A difference for Africans between observed health and the counterfactual health under the "Whites' model" thus provides an evaluation of the direct segregation taking place. Indeed, if there was no segregation, health under the Africans' model (observed health) should be equal to health under the Whites' model (counterfactual) for any given socio-economic characteristics.

Formally, lets call h_{ij} the health of individual i belonging to racial group j, h_{ij} may be assumed to depend on three sets of arguments: individual and household observable socio-demographic characteristics (x)[8], unobservable characteristics and health hazard summarized by κ and a set of

[7] Social recognition of disease depends on the economic and social value of the person.

[8] A variety of factors at the household and community levels have a direct influence on individual health outcomes. They cover household actions and risk factors, household assets, community factors, health service provision, health finance, supply in related sectors and public policies. All these informations are unfortunately not available in the 1999 OHS.

parameters corresponding to the health production process linking socio-demographic characteristics to observed health (η):

(1) $h_{ij} | H(x_{ij}, \kappa_{ij}; \eta_j)$

Within this framework, observed differences in average health between two racial groups may come from two different potential sources:

i) A difference in average socio-demographic characteristics between the two racial groups,

ii) A difference in the health demand process between the two racial groups

The former source can be seen as indirect segregation effect since it is segregation on socio-demographic characteristics such as education or living conditions that lead to differences in average health. The latter corresponds to direct segregation effect or discrimination since individuals with the same socio-demographic characteristics will have different health levels if belonging to different racial groups.

It is thus possible to decompose observed health differences into these two components as follows (2 racial groups: *a* for Africans and *w for Whites*):

(2) Indirect segregation $I^i_{wa} | H(x_{iw}, \kappa_{iw}; \eta_w) 4 H(x_{ia}, \kappa_{ia}; \eta_w)$

(3) Direct segregation: $D^i_{wa} | H(x_{iw}, \kappa_{iw}; \eta_w) 4 H(x_{iw}, \kappa_{iw}; \eta_a)$

The preceding formulation presented here at the individual level can then be aggregated to evaluate the overall average effect. It is important here to compute the simulations at the individual level since health shocks included in the κ term play a central role.

In other words, the indirect segregation effect, *I*, is obtained by comparing the observed health for racial group *w* and the hypothetical health obtained by simulating on racial group *a* the health demand process parameters of racial group *w*. Likewise, the direct segregation effect is obtained by comparing observed health for racial group *w* and the hypothetical health obtained by simulating on racial group *w* the health production process parameters of racial group *a*.

This approach falls in the line of the well-known Blinder-Oaxaca decomposition methodology. A common problem with this methodology is path-dependence since the two effects are likely to depend on the reference (population or parameters) used for the simulation. In other words, it is generally the case that:

$I^{wa} \prod I^{aw}$; $D^{wa} \prod D^{aw}$

In the application that follows, this ambiguity will be taken into account by considering simultaneously alternative definitions of the various effects, which provides a robustness test for the decomposition results.

This decomposition of health differences has strong policy implication since the evidence of direct segregation effect would reflect that some mechanisms are still in place in terms of discrimination on health, which do not give Africans and Whites equal chances even when endowed with the same socio-demographic characteristics. If only indirect segregation is at work however, the only way to equalize health between racial groups is to focus on long term programs aiming at equalising socio-economic determinants of heath such as education.

4. Econometric estimations

The econometric estimation of health demand functions is done using self-evaluated health status, which includes five health levels (very poor health, poor health, average health, good health, very good health).

We first estimate a global health equation using this variable through an ordered Probit model for the pooled sample of Africans and Whites, which results are shown in table 2. Here, **race** is conceptualised as a control variable representing group membership, indicating whether Africans differ from Whites, after other factors are controlled. Unsurprisingly, we find a strong positive and significant coefficient for the white dummy showing that some type of segregation is at stake since Whites are, all things being equal, in better health than Africans. In South Africa, race constituted a significant differential connected with inequality in health care. Apartheid's oppressive and discriminatory measures secured the Whites their privileged position in the South African society. The Africans were excluded from any participation in health decision-making by the failure to grant them political rights. There was a long tradition of concentrating the health care supply (in terms of both quality and quantity) in favour of the white population. There was also a long history of exclusion of Africans from facilities which were reserved exclusively for Whites or kept separate, but strikingly unequal, for the different colour groups. In fact, the white population is better served and provided for in almost every area of health care, while the other population groups are in markedly deprived position.

Table 4 : Ordered Probit estimation of a reduced health demand function

	Whites and Africans	Whites	Africans
White	0.041 *(0.019)*		

Male	0.057		0.060
	(0.008)		*(0.0081)*
Education	0.030	0.014	0.030
	(0.001)	*(0.0032)*	*(0.0012)*
Age	-0.013		-0.013
	(0.001)		*(0.0008)*
Age ^{2}	-0.0009	-0.0002	-0.0008
	(0.00001)	*(0.00001)*	*(0.00001)*
Household size	-0.004	-0.024	-0.004
	(0.0014)	*(0.0103)*	*(0.0013)*
Male head	0.035	-0.074	0.039
	(0.0088)	*(0.0442)*	*(0.0089)*
Age of the head	-0.003	-0.007	-0.002
	(0.0003)	*(0.0014)*	*(0.0003)*
Health insurance coverage in the household	0.048	0.057	0.038
	(0.0139)	*(0.0298)*	*(0.0158)*
Hunger in the household during the preceeding year	-0.175		-0.178
	(0.0095)		*(0.0096)*
Clinic/hospital within 30 minute walk	0.032	-0.051	0.038
	(0.0082)	*(0.0307)*	*(0.0085)*
Instrumented total monthly income	0.041	0.214	0.036
	(0.0058)	*(0.0264)*	*(0.0059)*
Urban location	-0.034	0.081	-0.040
	(0.0090)	*(0.0419)*	*(0.0092)*
Number of observations	90477	7876	82601
LR chi2	11846.34	1051.40	10675.76
Pseudo-R2	0.0605	0.0698	0.0591
Cut 1	-3.038	-2.812	-3.029
	(0.0256)	*(0.1449)*	*(0.0261)*
Cut 2	-2.135	-1.876	-2.125
	(0.0217)	*(0.1259)*	*(0.0222)*
Cut 3	-1.543	-1.151	-1.540
	(0.0209)	*(0.123)*	*(0.0214)*
Cut 4	-0.336	0.174	-0.341
	(0.0204)	*(0.1223)*	*(0.0208)*

Notes : A stepwise estimation was used. Standards deviation are in brackets.
All coefficients are statistically significant at 0%, except for the variable White at 3.4%.

We also find usual and intuitive results concerning the main socio-demographic variables. Be a **male** is a strong positive determinant of health status as well as belonging to a household where head is a man. This is due to the fact that women are generally recognised to be in worst health than men because of biological risks, acquired risks, limited access to health care, or social and gender segregation. **Be educated** is in favour of declaring a high level of health. Strauss and Thomas (1995) noted that education affects human capital outcomes by raising the technical efficiency with which inputs are used or by increasing the allocative efficiency of inputs use. **Age** is a negative determinant of health level as the level of health capital decreased with age [Grossman (1972)].

In each sample, the **wealth effect** acts in a positive way on the health status. The economical variables seem to be discriminated elements for health care access in South Africa. The instrumented level of monthly income was used as an indicator of resources. It is positively correlated to health level. This is confirmed by the estimated effect of the family size. Large families penalised South African to have a good health level. The **size of the household** partly

determines the family financial capacity but also the learning effects of self-medication or the increase of the sanitary risks [Ellis and Mwabu (1990), Heller (1982)]. Having an **hunger experience** is deterious to health status.

Having at least one person covered by a **medical insurance** is positively related to health level. It is an indication of the capacity to pay, the orientation of the preferences of the household and the quality of care. Two types of risks (economic and medical) are reduced and the cost of care is lower. In South Africa, historically, the membership of a medical insurance is part of the employment benefits for the formal workers. It is also very common for the rest of the family to be covered. The kind of benefits package varies from a relatively comprehensive ones with free choice of provider paid on a fee-for-service basis to a lowest benefit coverage largely restricted to primary health care services, with panel doctors on a contract basis. The estimated effect of this variable supports the choice of a national medical insurance as a vector of decrease in unequal health status.

Having a clinic/hospital around is positively related to health status. In South Africa, public clinics are the main supplier of basic health care. Our estimation confirm the fundamental role of primary health care supply for health. Nevertheless, after the implementation of the free health care policy in public clinics, evaluations showed that a lot of sick people were asked to go back home without being cared for. Since 1995, the development of medical facilities by construction, rehabilitation or transformation of hospitals in clinics has started to correct the free health care policy failure

The variable indicating the **urban location** takes two ideas into account. It shows the better medical supply in the south african urban areas but also the facility of access to health care for Whites in these areas. In the pooled sample of Africans and Whites, the urbanites seem to declare worst health status than rural people. But, in towns Whites are over serviced and Africans are generally under serviced. The rapid migration of Africans to the metropolitan centres has led to a growing problem of urban poverty. The townships and squatters camps are living in a lack of medical structures. The low standard of living added to the lack of medical infrastructure creates an environment where the geographical and financial access to health care has been reduced generating a low level of health among Africans. We conclude that living in an town could act in opposite ways for Africans and for Whites because of past geographical segregation in South Africa.

Effectively, the pooled sample estimation alone does not allow to distinguish indirect segregation (Whites may be in better health because they have better socio-demographic characteristics) from

direct segregation (even with similar characteristics, Whites may be in better health than Africans). A first insight about direct segregation, which may be taking place, can be seen through the comparison of estimations conducted separately for Whites and Africans as shown table 2. Here, we supposed that models of demand for health should be stratified by race because race is a resource that form a context for behaviour [Jackson (1989)]. As supposed by White-Means (1995), "the cultural norms of families, the experiences of discrimination, and the ability to cope with one's environment vary by race".

It can be seen from these estimations that some **strong differences arise between** Whites and Africans concerning health determinants. First, concerning individual characteristics, the following differences can be observed: **gender** is an important factor for Africans but not for Whites, education plays a greater role for Africans, facing ageing causes more health degradation for Africans. This is due to structural backwardness of Africans on social integration, health expectancy or education in South Africa.

Concerning **household characteristics**, **access to a public clinic/h**ospital, **urban** location and the **sex of household** head play opposite roles for Whites and Africans. In fact, Africans have a very limited access to the most sophisticated type of treatment dispensed at private practitioners and private hospitals. Public clinics are thus their main supplier of essential health care. Among Whites, being cared in a public hospital or a clinic is actually a sign of poverty and very bad health status or severity of illness.

Holding health insurance and **income** play a stronger role for Whites. In average, they have better health risks coverage and received more expansive health care of better quality than Africans.

Finally, differences in ordered Probit thresholds are quite important to note here. Indeed, thresholds for Africans are below those of Whites. Even though these thresholds are not directly comparable[9], this is consistent with the idea mentioned above of a potential response category cut-point shift leading Africans to declare being in a better health than Whites when facing the same health conditions.

[9] See Appendix A for a discussion of this point.

5. Decomposition results

In order to provide straightforward results, we computed the decomposition procedure on the estimation of a simple Probit model on the binary variable "reported in good health" / "reported in bad health"[10].

First decomposition results

We computed a first decomposition procedure using the whole set of estimated coefficients, i.e. without taking into account the potential differences in health references between groups (Appendix A, equation 4b). Simulation results shown in table 3 present the two possible ways of evaluating direct and indirect segregation.

Table* 3 *: Observed and simulated percentage of individual self-declared in bad health

	White population structure	**African population structure**
White health model	**2.36**	*8.59*
African health model	*1.72*	**5.37**

Note: Bold figures refer to the observed situation. Italic figures are counter-factual simulation results.

Table 3 can be read in two ways. Horizontally, differences in figures correspond to indirect segregation effect (segregation through differences in socio-demographic characteristics) and, vertically, differences are due to direct segregation effect (differences in health production models).

Indirect segregation in favour of Whites is clearly observable here: the first line shows that, if Africans' health was determined by the same model as Whites', differences in average socio-demographic characteristics would lead to 6.23 percentage point more Africans in bad health than Whites. Similarly, the second line shows that, if Whites were facing the Africans' conditions, differences in socio-demographic characteristics would still lead to 3.65 percentage points more Africans in bad health than Whites.

However, as discussed in details in Appendix A, not taking into account potential differences in health references between groups over-evaluates the indirect segregation in favour of Whites and under-evaluates direct segregation in favour of Whites. Indeed, the columns of Table 3 actually indicates **direct segregation *against* Whites** since, according to these results, Whites would be in better health if facing the Africans' model and Africans would be in poorer

[10] The binary variable takes 0 for poor and very poor health and 1 for better declared health status. Probit results are very similar to those of the ordered Probit model, are not presented here and need no further discussion.

health if facing the Whites' model. This is of course quite counter-intuitive and seems to be entirely due to reporting biases inherent to SAH and to the procedure of decomposition.

Taking into account differences in health references

The ideal way to surmount this problem is to model the reporting bias based on more "objective" indicators of true health [Lindeboom and van Doorslaer (2003)] and the use of "vignettes" to fix the scale [Murray *et al.* (2001)]. Using 1999 OHS, this solution is not applicable. As discussed in details in Appendix A, an (imperfect) way of taking into account differences in health references is to compute simulations keeping constant terms fixed for each group (Appendix A, equation B4c). With this procedure, simulation results are the following:

Table 4: Observed and simulated percentage of individual self-declared in bad health
(Constant term fixed for each racial group)

	White population structure	**African population structure**
White health model	**2.36**	*2.79*
African health model	*7.51*	**5.37**

Note: Bold figures refer to the observed situation. Italic figures are counter-factual simulation results.

Table 4 provides drastically different results. Indeed, evaluated **direct segregation** (columns) is **large** and **robust** since Whites facing Africans conditions would be 7.51% in bad health against 2.36% observed, and Africans facing Whites' model would only be 2.79% in bad health against 5.37% observed. However, **indirect segregation is not robust** any more with this specification since the second line actually pleads for indirect segregation *against* Whites, which is of course very counter-intuitive. Even though, in our case, the analytic form for the under/over-evaluation issue is unclear[11], it thus seems quite certain that this second simulation over-estimates the direct segregation in favour of Whites and under-estimates the indirect segregation in favour of Whites.

[11] In our case $\bar{x}_{iw}.\eta_w \; \} \; \bar{x}_{ia}.\eta_a$, which does not allow for a clear-cut analytical form (see Appendix B.4.).

"Average" simulations

Since the two previous simulations provide respectively under and over-evaluations of direct segregation, we now compute "intermediate" simulations. As discussed in Appendix A, the two previous simulations only differ by the constant term used. A first possible "average" simulation thus consists in using the average of the two estimated constant terms (cf. Appendix A.4., equation A4d, for details). With this procedure, simulation results are the following:

Table 5: Observed and simulated percentage of individual self-declared in bad health
("Average" constant term)

	White population structure	**African population structure**
White health model	**2.36**	*5.09*
African health model	*3.65*	**5.37**

Note: Bold figures refer to the observed situation. Italic figures are counter-factual simulation results.

Using this specification, we find robust direct and indirect segregation in favour of Whites, direct segregation accounting for between 9% and 43% of the observed difference in self-evaluated health, whereas indirect segregation explains between 57% and 91% of this difference.

Another possible way to compute an alternative "average" simulation consists in running a single regression on Africans and Whites with all explanatory variables (except the constant term) crossed with racial dummies, thus imposing a common constant term for Whites and Africans.

Table 6: Observed and simulated percentage of individual self-declared in bad health
(Common constant term)

	White population structure	**African population structure**
White health model	**2.36**	*4.79*
African health model	*3.40*	**5.37**

Note: Bold figures refer to the observed situation. Italic figures are counter-factual simulation results.

Using this specification, we find again that differences in self-assessed health comes from both direct and indirect segregation in favour of Whites with a magnitude ranging respectively between 19% and 35% of the observed difference in self-evaluated health whereas indirect segregation explains between 65% and 81% of this difference.

Conclusion

In this paper we assessed the question of health discrimination in South Africa using a SAH indicator. Our aim was first to evaluate differences in SAH between Africans and Whites. Unsurprisingly, we find strong evidence of Whites being in better health than Africans even though the indicator has good chances to under-evaluate this gap.

In a second step, we ran health equation estimations using an ordered Probit specification. Estimation results, which are consistent with theories and former empirical results on health determinants, provide a first set of explanations for health differences between racial groups. Indeed, major health determinant variables such as education, income or household size play against poorer endowed Africans compared to richer and better educated Whites. This line of explanation is what we call "indirect segregation", the health gap being induced by segregation in other dimensions such as education of wealth. However, regression results still show a significant effect of racial dummies, which pleads in favour of "direct segregation", i.e. differences in health, which cannot be explained by differences in socio-economic characteristics.

The next step of our work consists in estimating health equations separately for Africans and Whites. We find strong support for differences in the models. In particular, gender is an important factor for Africans but not for White, education plays a greater role for Africans and facing ageing causes more health degradation for Africans. These differences can be explained by structural backwardness of Africans on social integration, health expectancy or education in South Africa. Moreover, access to a public clinic/hospital, urban location and the sex of household head play opposite roles for Whites and Africans. In fact, Africans have a very limited access to the most sophisticated type of treatment dispensed at private practitioners and private hospitals. Public clinics are the main supplier of essential health care for them acting favourably for health. Among Whites, being cared in a public hospital or a clinic is a sign of poverty and very bad health status or severity of illness. These results show that besides the indirect segregation induced by lower socio-demographic endowments, Africans suffer direct segregation in heath.

Finally, we try to evaluate the respective magnitude of direct and indirect segregation effect on observed health differences between Africans and Whites through Oaxaca-Blinder type decomposition procedures. In order to account for biases induced by the use of a subjective measure for health, we use four different types of decomposition. We find some support for a persisting direct segregation accounting for between 9% and 43% of the observed difference in SAH. This result has strong policy implications. Indeed, direct segregation of such a large magnitude shows that, even though Apartheid has been officially abandoned since 1990,

segregation on health may still be taking place in 1999. Indeed, differences in health between Africans and Whites may not be solely due to differences in health determinants such as education or income, which can be imputed to the former regime, but seem to be also caused by persisting direct segregation.

Our results should however be taken with very much caution. Indeed, if "average" simulations tend to show evidence of a strong direct segregation against Africans, our decomposition results are dependent on the specification used and the robustness of our results should be formally tested in order to validate our findings. However, such robustness tests would require the necessary information to overcome the identification issue. More generally,, our work shows that potential biases in self assessed health concerning differences in health references is a major issue, which should be further addressed. Finally, direct segregation is multi-dimensional. Our estimation results show that it affects major factors such as returns to education, income or access to hospitals. Each of these dimensions still needs to be further analysed and evaluated.

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Appendix A: Technical note

A.1. The general model

Let's start with the general linear model. Unobserved real health (H_{iw}^{*}) for individual *i* belonging to race *w* can be written as follows:

$$H_{iw}^{*} \mid x_{iw}.\eta_w \; 2 \; \nu_w 2 \; \kappa_{iw} \qquad \text{(A1)}$$

where η_w and ν_w are race specific parameters, x_{iw} corresponds to individual observable characteristics and κ_{iw} to unobservable characteristics. Using this formulation, individual *i* belonging to race *w* will declare to be in good health only if his/her real health is above some race-specific threshold level T_w, formally, observed self-assessed health status (H^o) can be modelled as follows:

$$H^o \mid 1(good\ health)\ \ if\ \ H^*_{iw} \mid x_{iw}.\eta_w 2 \nu_w 2 \kappa_{iw} \} T_w \qquad \text{(A2)}$$

Model (A2) is however unidentified. Indeed the variance of κ_{iw} can not be identified nor can ν_w and T_w separately. The estimable model (through a Probit model for example) is:

$$x_{iw}.\frac{\eta_w}{\omega_w} 2 \frac{(\nu_w 4 T_w)}{\omega_w} 2 \frac{\kappa_{iw}}{\omega_w} \} 0 \qquad \text{(A3)}$$

where ω_w is the standard error of κ_{iw}.

Simulating Whites' health if confronted to Africans' model should formally be done through the computation of the following model:

$x_{iw}.\eta_a 2 \nu_a 2 \kappa_{iw} \} T_w$ ♥ Good (counterfactual) health (A4)

$x_{iw}.\eta_a 2 \nu_a 2 \kappa_{iw} \Omega T_w$ ♥ Bad (counterfactual) health

This corresponds to applying the "Africans model" to Whites observed and unobserved characteristics as well as Whites' conception of being in "good" or "bad" health. Model (A4) is in turn strictly identical to:

$\frac{x_{iw}.\eta_a}{\omega_w} 2 \frac{\nu_a 4 T_w}{\omega_w} 2 \frac{\kappa_{iw}}{\omega_w} \} 0$ ♥ Good (counterfactual) health (A4a)

$\frac{x_{iw}.\eta_a}{\omega_w} 2 \frac{\nu_a 4 T_w}{\omega_w} 2 \frac{\kappa_{iw}}{\omega_w} \{ 0$ ♥ Bad (counterfactual) health

In order to compute the simulations proposed in the methodology section, three issues are here at stake: *i)* the computation of $\frac{\kappa_{iw}}{\omega_w}$, *ii)* the approximation of $\frac{\omega_a}{\omega_w}$ and *iii)* the approximation of $\frac{\nu_a 4 T_w}{\omega_w}$.

A.2. Drawing normalised residuals

Following a Probit model estimation of (A3), residuals ($\frac{\kappa_{iw}}{\omega_w}$) can be easily drawn for all observed individuals from the following standard conditional normal distribution $N(0,1 \mid u \} 4 x_{iw}.\hat{a}_w 4 \hat{b}_w)$ or $N(0,1 \mid u \{ 4 x_{iw}.\hat{a}_w 4 \hat{b}_w)$, where $\hat{a}_w$ and $\hat{b}_w$ are estimated coefficients for respectively $\frac{\eta_w}{\omega_w}$ and $\frac{(\nu_w 4 T_w)}{\omega_w}$.

A.3. Approximation of residual variances

Even though the residual variance can not be directly identified for qualitative response models, some valuable information can here be taken from the 5-level answer to the question on self-assessed health. Indeed, it can be assumed that a first order approximation of unobserved health (H^*) variances between races may be given by the ratio of self-assessed health declaration (H^o) variances.
If this holds, it is then straightforward from (A2) that:

$$\frac{\omega_w^2}{\omega_b^2} \mid \frac{Var(H_w^g)}{Var(H_a^g)}.\frac{12 Var(x_{ia}.\hat{a}_a 2 \hat{b}_a)}{12 Var(x_{iw}.\hat{a}_w 2 \hat{b}_w)}$$

***A.4.* Approximation of $\frac{\nu_a 4 T_w}{\omega_w}$**

More problematic is the question of the approximation of approximation of $\frac{\nu_a 4 T_w}{\omega_w}$. Indeed, due to identification issues, only approximations are available: ($\hat{b}_w$ | $\frac{\nu_w 4 T_w}{\omega_w}$) and ($\hat{b}_a . \frac{\hat{\omega}_a}{\hat{\omega}_w}$| $\frac{\nu_a 4 T_a}{\omega_w}$) being the most straightforward. The main issue is thus to try to evaluate if available approximations provide over or under-evaluations. This issue is of course very much case-specific.
Here, concerning health for Whites and Africans, we can make the following two hypotheses:

H1: Unobserved health (H^*) is on average higher for Whites than for Africans ($\overline{H}^*_{iw}$ } $\overline{H}^*_{ib}$)

H2: The health threshold for Africans to declare to be in good health is lower than for Whites (T_w } T_a)[12]

A first proxy for model (A4a)

Given H2, it is straightforward that $\frac{\nu_a 4 T_b}{\omega_w}$ } $\frac{\nu_a 4 T_w}{\omega_w}$, which gives valuable information for the first straightforward simulation model:

$\frac{x_{iw} . \eta_a}{\omega_w} 2 \frac{\nu_a 4 T_a}{\omega_w} 2 \frac{\kappa_{iw}}{\omega_w}$ } 0 ♥ Good (counterfactual) health (A4b)

Indeed, simulating model (A4b) as a proxy for (A4a) thus leads to an over-evaluation of Whites' health under the Africans' model. Symmetrically, model (A4b) leads to an under-evaluation of Africans' health under the Whites' model.

A second proxy for model (A4a)

A second proxy for model (A4a) is given by:

$\frac{x_{iw} . \eta_a}{\omega_w} 2 \frac{\nu_w 4 T_w}{\omega_w} 2 \frac{\kappa_{iw}}{\omega_w}$ } 0 ♥ Good (counterfactual) health (A4c)

Taking the average of model (A1) for each racial group provides:

ν_w| $\overline{H}^*_{iw} 4 \overline{x}_{iw} . \eta$

ν_a| $\overline{H}^*_{ia} 4 \overline{x}_{ia} . \eta_a$ (A5)

Given hypothesis (H1), it is straightforward that

$\overline{x}_{iw} . \eta_w$ { $\overline{x}_{ia} . \eta_a$ ♥ ν_w } ν_a ♥ $\frac{\nu_w 4 T_w}{\omega_w}$ } $\frac{\nu_a 4 T_w}{\omega_w}$ (A6)

If this holds then it is clear that model (A4c) leads to an over-evaluation of Whites' health under the Africans' model. Symmetrically, model (A4c) leads to an under-evaluation of Africans' health under the Whites' model.However, (A6) is a sufficient but not a necessary condition.

"Average" proxy for model (B4a)

If it happens that there is some evidence that model (A4c) provides under-evaluations when model (A4b) provides over-evaluations, the following "average constant model" may be simulated:

$\frac{x_{iw} . \eta_b}{\omega_w} 2 \frac{(\nu_w 4 T_w) 2 (\nu_b 4 T_b)}{2 . \omega_w} 2 \frac{\kappa_{iw}}{\omega_w}$ } 0 ♥ Good (counterfactual) health (A4d)

[12] See Iburg *et al.* (2000).