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Changes in socioeconomic inequality in self-assessed health in South Africa: The contributions of changes in inequalities between and within socioeconomic groups

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ABSTRACT

Globally, poor health is associated with lower socioeconomic status (i.e., the gradient). While significant sociodemographic drivers of socioeconomic inequalities have been documented in South Africa, little is known about changes in socioeconomic inequalities in health between and within socioeconomic groups, an essential consideration for closing the gaps between socioeconomic groups. This paper assesses changes in health inequalities in South Africa, using self-assessed health (SAH) to uncover the relative contributions of inequalities between and within socioeconomic groups to changes in socioeconomic inequalities in SAH. It uses data from five waves (2008, 2010/11, 2012, 2014/15, and 2017) of South Africa's nationally representative National Income Dynamics Study (NIDS) as cross-sectional with a final sample size ranging between 13,732 and 21,303 adults (>18 years). Based on five categories, SAH was recategorised and dichotomised as "good health" with SAH = 1. Socioeconomic status and quintiles were based on per capita household expenditure. The standard concentration index measured socioeconomic inequality in SAH. A recent methodology decomposes changes in the concentration index of SAH into changes in inequality within and between socioeconomic groups. A pro-poor shift or change is when socioeconomic inequality in health (including for between- and within-socioeconomic groups) reduces between two time periods, while an increase in inequalities means a pro-rich shift or change. The results show a significant pro-rich gradient in SAH among adults in South Africa (concentration index ranging between 0.0053 and 0.0327), with good health reported more by relatively wealthier adults than their more socioeconomically deprived counterparts. This pro-rich gradient declined overall between 2008 and 2017 (a pro-poor shift), associated mainly (between 96% and 100%) with reduced inequalities between socioeconomic groups, i.e., closing gaps between socioeconomic groups. Addressing health inequalities in South Africa requires a multisectoral approach prioritising socioeconomically deprived individuals and policy to reduce health disparities between groups that leave no one behind.

Abbreviations

AIDs	Acquired immune deficiency syndrome
ARVs	Antiretrovirals
C	Concentration index
C_B	Inequality between socioeconomic groups
C_W	Inequality within socioeconomic groups
DALYs	Disability-adjusted life years
HIV	Human immunodeficiency virus
NIDS	National Income Dynamics Study
PSU	Primary sampling unit
SAH	Self-assessed health
SEI	Socioeconomic inequality

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1. Introduction

Health inequalities have been documented globally to the detriment of disadvantaged population groups, and this phenomenon is often called *the gradient* (Adler et al., 1994; Deaton, 2002; Ichoku et al., 2011). Traditionally, following the publication of the Black Report in the 1980s, health inequalities research focused on understanding inequalities in morbidity and mortality as key measurable health outcomes (Kunst et al., 2005). A growing emphasis on the multidimensional nature of health has led to many research papers recently assessing inequalities in self-assessed health, which usually involves using a single-item measure with individuals evaluating their health status from excellent to poor (Hu et al., 2016; Kunst et al., 2005; Moor et al., 2017; Sözmen et al., 2012). As an implicitly multidimensional measure of health that predicts morbidity, mortality and health service utilisation (Bopp et al., 2012; DeSalvo et al., 2006), understanding the single-item self-assessed health indicator requires unpacking its various implicit components, not limited to physical, psychological and emotional health and well-being. As noted regarding the gradient, studies focusing on self-assessed health in different parts of the world generally report that individuals in poorer socioeconomic groups, including those in lower education groups, tend to assess their health as "poorer" than their more affluent counterparts (Ataguba et al., 2015; Hu et al., 2016; Moor et al., 2017; Sözmen et al., 2012), aligning with results observed for inequalities in morbidity or mortality. Sometimes, the gradient is worse for self-assessed health inequalities than morbidity or mortality inequalities (Hu et al., 2016).

Ataguba (2019), in a recent paper, demonstrates the need for seasonality adjustments to compare certain socioeconomic inequalities in health between countries reliably. While studies reported in the literature, especially for cross-country assessments of inequalities in morbidity and mortality, have no adjustments for seasonality, they still show the existence of the gradient for countries from different income statuses (Mackenbach et al., 2008; Umuhoza & Ataguba, 2018; Wagstaff, 2000; Wagstaff et al., 1989). These inequalities are exacerbated by the distribution of many social determinants of health (Bell et al., 2023) that are described as the causes of poor or ill health. These social determinants of health are "the conditions in which people are born, grow, live, work and age and the distribution of power, money and resources" (Bell et al., 2023, p. 127). In the context of self-assessed health, Moor et al. (2017) reported in their systematic review that while material factors may explain a large share of observed disparities in self-assessed health, other critical factors such as psychosocial and behavioural factors significantly explain socioeconomic inequalities in self-assessed health for the eleven studies in their review. In South Africa, with significant health inequalities (Alaba & Chola, 2014; Ataguba, 2013; Ataguba et al., 2011; Nkonki et al., 2011; Nwosu & Oyenubi, 2021; Zere & McIntyre, 2003) and a high burden of communicable and non-communicable diseases (Modjadji, 2021), Ataguba et al. (2015) used a decomposition framework to unpack the significant drivers of socioeconomic inequalities in self-assessed health. Their research highlighted the key drivers as essentially linked to the social determinants of health, including social protection, education, employment and housing infrastructure (Ataguba et al., 2015).

Based on the literature and in the broader sphere of inequalities in health, there is a significant focus on documenting the gradient in ill health in South Africa and elsewhere, including the decomposition of health inequalities (Alaba & Chola, 2014) and changes in socioeconomic inequalities in health between two time periods (Omotoso & Koch, 2018) to understand the significant socio-demographic drivers. This paper recognises these within the remit of what is known. However, little is known about changes in socioeconomic disparities in health between- and within-socioeconomic groups or quintiles using morbidity, mortality or self-assessed health status. Traditional approaches to decomposing changes in socioeconomic inequality in health, such as the total differential approach and the Oaxaca-type decomposition (O'Donnell et al., 2008), show whether inequalities in health have changed over time, including the covariates explaining the changes but do not provide an overview of between- and within-socioeconomic groups dynamics, for instance, including among those from poorer socioeconomic groups. These traditional approaches tend to treat inequalities as mainly concerning differences between groups. Importantly, policies addressing health inequalities between- and within-group may differ. Policies prioritising individuals in similar socioeconomic groups are needed to address significant socioeconomic inequalities within socioeconomic groups, especially because the socioeconomic group(s) driving within-group inequality is identifiable. On the other hand, significant inequalities between socioeconomic groups require prioritising deprived socioeconomic groups to close the gaps between groups (Ataguba et al., 2023).

Therefore, it is critical to understand whether socioeconomic inequalities are reducing over time and whether the reductions are driven by substantial reductions or changes between- or within-socioeconomic groups (Ataguba et al., 2023), an important policy consideration in many countries, especially in trying to close the gaps between the haves and have-nots and in leaving no one behind (United Nations, 2022). By way of novelty, this paper uses the recent Ataguba et al. (2023) methodology to assess changes in health inequalities in South Africa, a relatively unequal country globally, to uncover the relative contributions of between- and within-socioeconomic groups to changes in socioeconomic inequalities in self-assessed health between time periods. To the author's knowledge, no studies in South Africa show the relative contributions of between- and within-socioeconomic groups to inequalities in self-assessed health. Moreover, understanding this provides an avenue to use policy to address South Africa's health inequalities and prioritise socioeconomic groups that are often left behind.

2. Methods

2.1. Data

Data come from five waves of South Africa's nationally representative survey called the National Income Dynamics Study (NIDS) (Southern Africa Labour and Development Research Unit, 2018a, 2018b; 2018c; 2018d; 2018e). The NIDS is a longitudinal survey that began in 2008 and uses a stratified two-stage cluster sampling design. In the first stage, a sample of primary sampling units (PSUs) is drawn from Statistics South Africa's 2003 Master Sample consisting of 3000 PSUs and in the second stage, dwellings within each PSU are selected. Table 1 summarises the NIDS datasets used for analysis, including the sample of adults (>18 years old) in each NIDS wave. Specifically, NIDS Wave 1 was completed in 2008, Wave 2 in 2010/11, Wave 3 in 2012, Wave 4 in 2014/15, and the fifth Wave was completed in 2017. The minimum age (>18 years) was selected because this paper is interested in adults' self-assessed health, especially those who have attained the age for completing secondary-level education and are knowledgeable enough to

Table 1
Overview of the NIDS datasets for analysis.

	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5
Year[a]	2008	2010/11	2012	2014/15	2017
Number of individuals in the sample[a]	26,776	28,537	32,582	37,368	39,434
Adults (>18 years) included in the analysis[b]	13,732	15,152	16,280	20,095	21,303

[a] Southern Africa Labour and Development Research Unit (2018e)
[b] Authors' estimation.
Sources:

provide meaningful responses to self-assessed health questions in the NIDS. In South Africa, after 18 years, most of the population has completed secondary education (Ataguba et al., 2015). The NIDS was a panel survey with datasets intended to assess and track the dimensions of well-being, including health, education, access to social services and others. Because each NIDS Wave is nationally representative, and there was significant attrition among certain population groups, this paper uses the NIDS datasets cross-sectionally, as it was not interested in following specific individuals or households between waves. More details for using the NIDS data cross-sectionally have been outlined in the limitations to avoid duplication.

2.2. Analytical method

Health was assessed using the self-assessed health status (SAH). Although operationalised as a single-item indicator, SAH is a multidimensional measure of health that includes many dimensions or aspects of people's health beyond reported illness and psychological health (Graf & Patrick, 2016; Manderbacka, 1998; Simon et al., 2005). SAH may be described as a "product and producer of particular health trajectories and outcomes" (Graf & Patrick, 2016, p. 184), which encompasses functional ability, demographics, physician assessment, and attitudes and perceptions shaped by people's relationship to the environment (Engle & Graney, 1986; Graf & Patrick, 2016; Manderbacka, 1998; Simon et al., 2005). It is important to note that SAH predicts morbidity and mortality (DeSalvo et al., 2006; Idler & Benyamini, 1997; Idler et al., 2000). Also, "inequalities in SAH by income do have predictive power for the [...] inequalities in survival by income" (van Doorslaer & Gerdtham, 2003, p. 1621). NIDS datasets contain SAH, with each adult respondent rating their health status in one of the following five categories: excellent, very good, good, fair, or poor. Based on existing literature (See Kunst et al., 2005; for example), responses for the five categories were recategorised and dichotomised with SAH = 1 for "good health," corresponding to excellent, very good and good. SAH = 0 for "poor health" corresponds to fair and poor.

The standard concentration index (C), popularly used for assessing socioeconomic inequalities in health (Ataguba, 2022; Kakwani et al., 1997), was used to assess socioeconomic inequality in SAH in South Africa. Theoretically, the values of the standard concentration index for SAH range between -1 (a case where SAH = 1, i.e., "good health" for only the most socioeconomically deprived individual) and $+1$ (a case where SAH = 1 for only the least socioeconomically deprived individual). Generally, a positive value for C represents a pro-rich distribution of SAH because "good health" is reported more by wealthier than deprived adults. In contrast, a negative value means a pro-poor distribution where "good health" is predominantly reported by more deprived individuals. For a binary variable like SAH used in this paper, normalisation to the standard concentration index was recommended because the values of the index may not be in the $[-1, 1]$ range (Wagstaff, 2005). Recently, Ataguba (2022) showed that the frequently used normalisation procedures (Erreygers, 2009; Wagstaff, 2005) may produce counterintuitive results for policy. Therefore, this paper uses the standard concentration index to assess socioeconomic inequalities.

The recent Ataguba et al. (2023) methodology was used to assess the contributions of changes in inequality between- and within-socioeconomic groups to overall changes in socioeconomic inequalities in SAH. Notably, when the measure of socioeconomic status used for estimating the standard concentration index is used to form mutually exclusive groups (e.g., tertiles, quartiles, and quintiles), Ataguba et al. (2023) show that the standard concentration index (C) can be written as the sum of the within (C_W) and between (C_B) socioeconomic group components: $C = C_W + C_B$ as there will be no overlaps in the socioeconomic distribution. Based on this, and using quintiles of socioeconomic status, changes in socioeconomic inequalities in SAH between two time periods can be decomposed into changes in the within- and between-socioeconomic group components.

If C^t and C^{t-1} represent the standard concentration index for SAH at time t (a recent period) and $t-1$ (a previous period), respectively, changes in the socioeconomic inequalities in SAH (ΔC) between any two time periods can be written as (Ataguba et al., 2023):

$$\underbrace{\Delta C}_{C^t - C^{t-1}} = \underbrace{\Delta C_B}_{C_B^t - C_B^{t-1}} + \underbrace{\Delta C_W}_{C_W^t - C_W^{t-1}} \quad (1)$$

where C_B^t and C_W^t represent the between- and within-socioeconomic group concentration indices for the most recent period (t), respectively. While C_B^{t-1} and C_W^{t-1} are the between- and within-socioeconomic group concentration indices for the previous period ($t-1$), respectively.

Using quintiles of socioeconomic status such that the number of groups, $K = 5$, the within-group component (C_W) is computed as the weighted group-specific concentration indices (C_k) of SAH:

$$C_W = \sum_{k=1}^{K} C_{W_k} \quad (2)$$

where $C_{W_k} = s_k p_k C_k$. The weights for the k^{th} socioeconomic group's share of "good health" is represented by s_k and p_k represents weights for the k^{th} socioeconomic group's population share (roughly 20% each in this case of quintiles).

So, Equation (2) can also be rewritten as the sum of all within-socioeconomic group components.

$$C_W = \sum_{k=1}^{5} C_{W_k} = C_{W_1} + C_{W_2} + C_{W_3} + C_{W_4} + C_{W_5} \quad (3)$$

The between-group component (C_B) is the concentration index of a distribution where the average SAH for each socioeconomic group is assigned to each individual in the group, as this eliminates inequalities within socioeconomic groups (Ataguba et al., 2023). However, using the identity that $C = C_W + C_B$, it means that C_B is computable as:

$$C_B = C - C_W \quad (4)$$

once C and C_W have been computed separately. Alternatively, $C_W = C - C_B$, after computing C and C_B separately (Ataguba et al., 2023).

The convenient regression approach (Kakwani et al., 1997) was adopted to compute the concentration indices for SAH (C) and the other concentration indices in Equation (2). This was implemented in Stata (StataCorp, 2023) using the *-conindex-* user-written command (O'Donnell et al., 2016). Socioeconomic status and the quintiles of socioeconomic status were measured using per capita expenditure. Only two broad variables were used in the analyses. Besides the socioeconomic status variable, including the quintiles, the other essential variable used for the decomposition is the dichotomised SAH measure. These variables were selected based on the requirements for computing the concentration index and decomposing changes in the index into the between- and within-socioeconomic group components (Ataguba et al., 2023).

Following Ataguba et al. (2023), the standard errors for ΔC_B, ΔC_W and ΔC are computed via bootstrap methods with 1000 replications (Efron, 1987; Efron & Tibshirani, 1986) using the NIDS sampling design. Further, the relative contributions of ΔC_B and ΔC_W to ΔC are computed as $\left(\frac{\Delta C_B}{\Delta C}\right)\%$ and $\left(\frac{\Delta C_W}{\Delta C}\right)\%$, respectively.

Ataguba et al. (2023) characterise the different possible values for ΔC_B, ΔC_W and ΔC for interpretation. $\Delta C_B < 0$, $\Delta C_W < 0$ and $\Delta C < 0$ represent a pro-poor shift or change in the between-socioeconomic group component, within-socioeconomic group component, and the standard concentration index, respectively. A pro-poor change or shift corresponds to changes in socioeconomic inequalities (whether in the overall distribution (ΔC), between (ΔC_B) or within (ΔC_W) socioeconomic groups) "favouring" poorer socioeconomic groups. Conversely, a pro-rich shift ($\Delta C_B > 0$, $\Delta C_W > 0$ and $\Delta C > 0$) means that changes in socioeconomic inequalities "favour" wealthier socioeconomic groups. In simple terms, a pro-poor shift occurs when socioeconomic inequality in health (including for between- and within-socioeconomic groups) has reduced between two time periods. For example, when the concentration index that was previously estimated at $C_{t-1} = 0.50$ reduces to $C_t = 0.22$, it is considered a pro-poor shift. A pro-rich shift is the opposite where socioeconomic inequality in health increases between two time periods.

2.3. Analytical methods: non-technical summary

The concentration index was used to assess socioeconomic inequalities in self-assessed health. This index assesses how SAH is reported by adults in the population, from the most to least deprived. When good SAH is reported more by the least socioeconomically deprived adults, the concentration index has a positive value. A negative value means the opposite. Socioeconomic inequalities may increase or reduce between two time periods (i.e., change between two periods), with an increase between two periods, which is termed a "pro-rich" shift, meaning that the health of socioeconomically deprived adults is worsening, while reductions in socioeconomic inequalities, which is termed a "pro-poor" shift signify improvements in SAH of socioeconomically deprived adults relative to their more affluent counterparts. A recent methodology developed by Ataguba et al. (2023) was used to investigate how socioeconomic inequality, measured using this concentration index, increases or reduces between two time periods. This paper uses two broad variables for the main analysis: a measure of socioeconomic status used to compute the quintiles and the dichotomised measure of SAH. The Ataguba et al. methodology can decompose changes in socioeconomic inequality into changes in health inequalities between socioeconomic quintiles and within socioeconomic quintiles. Decomposing changes here means splitting the differences in overall SAH inequality between two periods into inequality attributable to within and between socioeconomic groups. So, the differences in SAH inequality between the two periods represent changes, while splitting this change within and between socioeconomic groups is the act of decomposing the change. This process uncovers whether changes in inequality between or within quintiles account for the worsening or reduction of socioeconomic disparities in SAH in the adult population. All these changes are assessed to see if they are statistically significant.

3. Results

The summary statistics in Table 2 show that most of the adult population (>18 years) (>53%) included in the analysis was females, and the average age was about 40 years between 2008 and 2017. The average household size ranged between 4.2 (in 2017) and 5.0 members (in 2010/11). A large proportion of the adults assessed their health as good (i.e., SAH = 1 "good health" for >80%), with the highest proportion (89.4%) recorded in 2017. The population is predominantly urban (>62%) and self-reported their race as black Africans (>77%). Tertiary education attainment improved over time, as the proportion of adults included in this analysis completing tertiary education increased from 17.2% to 27.0% between 2008 and 2017. The proportion with no formal schooling dropped from 9.6% to 5.1% in the same period. While there was a substantial drop in the proportion of married adults or those currently living together (dropping from 45.4% (in 2008) to 28.0% (in 2017)) and widowed adults (dropping from 11.3% to 5.4% between 2008 and 2017), there was a concomitant increase in the proportion of never-married adults (increasing from 43.4% in 2008 to 66.6% in 2017) (Table 2).

Socioeconomic inequalities in self-assessed health in South Africa, estimated using the concentration index, show a significantly pro-rich distribution between 2008 and 2017 (Table 3), mainly because the

Table 2
Weighted summary statistics, South Africa, 2008–2017

	Period 1 (2008)	Period 2 (2010/11)	Period 3 (2012)	Period 4 (2014/15)	Period 5 (2017)
Average age (in years) {Range} [Standard deviation]	39.6 {19–106} [15.6]	39.5 {19–104} [15.5]	39.9 {19–105} [15.5]	39.7 {19–109} [15.7]	39.7 {19–110} [15.4]
Average household size {Range} [Standard deviation]	4.6 {1–25} [3.2]	5.0 {1–41}[3.4]	4.6 {1–39}[3.2]	4.5 {1–31}[3.2]	4.2 {1–30}[3.1]
Self-assessed health (SAH)	80.5 (79.9–81.2)	89.0 (88.5–89.5)	88.0 (87.5–88.5)	88.3 (87.9–88.8)	89.4 (89.0–89.8)
Location					
Urban	62.2 (61.4–63.1)	62.2 (61.4–62.9)	64.3 (63.6–65.1)	64.0 (63.4–64.7)	66.4 (65.8–67.0)
Sex of adult					
Female	56.6 (55.7–57.4)	54.2 (53.4–55.0)	54.6 (53.9–55.4)	53.5 (52.9–54.2)	53.5 (52.8–54.2)
Private health insurance					
Yes	16.5 (15.8–17.1)	16.7 (16.1–17.3)	15.9 (15.4–16.5)	16.6 (16.1–17.1)	15.9 (15.4–16.4)
Race					
African	77.9 (77.2–78.6)	78.2 (77.5–78.8)	78.3 (77.7–78.9)	78.6 (78.0–79.1)	81.4 (80.9–81.9)
Coloured	8.3 (7.9–8.8)	8.5 (8.1–9.0)	9.2 (8.8–9.7)	9.0 (8.6–9.4)	8.7 (8.3–9.1)
Asian	2.4 (2.1–2.7)	2.8 (2.5–3.0)	2.6 (2.3–2.8)	2.8 (2.5–3.0)	2.1 (1.9–2.3)
White	11.4 (10.8–11.9)	10.5 (10.0–11.0)	9.9 (9.4–10.4)	9.6 (9.2–10.0)	7.7 (7.4–8.1)
Marital status					
Married or living together	45.4 (44.5–46.2)	41.7 (40.9–42.5)	38.9 (38.1–39.6)	30.5 (29.8–31.2)	28.0 (27.3–28.6)
Never married	43.4 (42.5–44.2)	48.4 (47.6–49.2)	50.3 (49.5–51.1)	64.5 (63.8–65.2)	66.6 (65.9–67.3)
Widowed or separated	11.3 (10.7–11.8)	9.9 (9.4–10.4)	10.8 (10.3–11.3)	5.0 (4.7–5.4)	5.4 (5.1–5.7)
Education					
No formal schooling	9.6 (9.1–10.1)	8.3 (7.8–8.7)	7.7 (7.3–8.1)	2.5 (2.3–2.7)	5.1 (4.8–5.4)
Primary school	20.0 (19.4–20.7)	17.6 (17.0–18.2)	16.8 (16.2–17.3)	15.3 (14.8–15.8)	12.6 (12.2–13.1)
Secondary school	53.2 (52.4–54.0)	55.2 (54.4–56.0)	55.8 (55.1–56.6)	55.9 (55.2–56.6)	55.3 (54.6–56.0)
Tertiary school	17.2 (16.5–17.8)	18.9 (18.3–19.5)	19.7 (19.1–20.3)	26.3 (25.7–26.9)	27.0 (26.4–27.6)

Notes: (1) All figures have been weighted and nationally representative of the adult population. Table 5 in the Appendix contains the sample size for each variable and the unweighted mean or percentage. (2) Percentages reported for categorical variables. (3) 95% confidence intervals for percentages reported in parenthesis.

Table 3
Decomposing socioeconomic inequality in SAH into between- and within-socioeconomic group components, South Africa, 2008–2017

	Period 1 (2008)	Period 2 (2010/11)	Period 3 (2012)	Period 4 (2014/15)	Period 5 (2017)
C_B	0.0325***	0.0054**	0.0061**	0.0071***	0.0105***
	(0.0033)	(0.0026)	(0.0029)	(0.0028)	(0.0019)
C_W	0.0002	0.0002	−0.0008	−0.0006	−0.0003
	(0.0008)	(0.0006)	(0.0007)	(0.0006)	(0.0005)
C	**0.0327*** **	**0.0056** **	**0.0053* **	**0.0065** **	**0.0102*** **
	(0.0034)	**(0.0026)**	**(0.0029)**	**(0.0030)**	**(0.0020)**
C_{W_1}	−0.0005**	−0.0008***	−0.0002	−0.0003*	−0.0001
	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
C_{W_2}	−0.0003	−0.0001	−0.0001	−0.0002	0.0000
	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
C_{W_3}	0.0003	0.0005**	−0.0002	0.0002	0.0000
	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0002)
C_{W_4}	0.0002	0.0002	−0.0004	−0.0001	−0.0002
	(0.0004)	(0.0003)	(0.0003)	(0.0003)	(0.0002)
C_{W_5}	0.0006	0.0003	0.0002	−0.0002	−0.0001
	(0.0004)	(0.0003)	(0.0003)	(0.0004)	(0.0002)
	Period 1 (2008)	**Period 2** (2010/11)	**Period 3** (2012)	**Period 4** (2014/15)	**Period 5** (2017)
Contributions: $\left(\frac{C_B}{C}\right)$% and $\left(\frac{C_W}{C}\right)$%					
	99.4%	96.4%	115.1%	109.2%	102.9%
	0.6%	3.6%	−15.1%	−9.2%	−2.9%
Contributions: $\left(\frac{C_{W_k}}{C_W}\right)$%					
	−166.7%	−800.0%	28.6%	50.0%	25.0%
	−100.0%	−100.0%	14.3%	33.3%	0.0%
	100.0%	500.0%	28.6%	−33.3%	0.0%
	66.7%	200.0%	57.1%	16.7%	50.0%
	200.0%	300.0%	−28.6%	33.3%	25.0%

Notes: C represents the overall concentration index, C_B the between socioeconomic group component, C_W the within socioeconomic group component, and C_{W_k} the contribution of each quintile (k) to the within-group component. Bootstrapped standard errors using 1000 replications are shown in parentheses. *, **,*** statistically significant at the 10%, 5% and 1% levels, respectively.

concentration indices were positive and statistically significant at conventional levels. However, the extent of pro-richness in SAH reduced between 2008 and 2017, with the concentration index dropping from 0.03 in 2008 to 0.01 in 2017. Recall that pro-rich SAH means wealthier adults in South Africa report better health than their more deprived counterparts. Socioeconomic inequalities in SAH in South Africa are driven mainly by disparities between socioeconomic groups (C_B). In 2008, for instance, C_B's contribution to C was estimated at 99.4%, while C_W contributed 0.6%. By 2017, C_B contributed 102.9% while C_W contributed −2.9% to the concentration index for SAH. The contributions of inequalities within socioeconomic groups to the overall concentration index (C_W) were minimal between 2008 and 2017 (Table 3).

Although socioeconomic inequalities in SAH among adults >18 years were pro-rich in South Africa between 2008 and 2017, there have been significant reductions in inequalities between these periods. As shown in Table 4, pro-poor shifts or changes in socioeconomic inequalities in SAH ($\Delta C < 0$) occurred between 2008 and every subsequent period. This means that subsequent years' socioeconomic inequalities in SAH among adults in South Africa are statistically less pro-rich than in 2008. Between 2008 and 2010/11, the positive concentration index for SAH shown in Table 3 reduced significantly by −0.027. This reduction level in socioeconomic inequalities in SAH was generally similar and statistically significant considering changes between 2008 and 2012 ($\Delta C = -0.027$), 2008 and 2014/15 ($\Delta C = -0.026$), and 2008 and 2017 ($\Delta C = -0.023$). Unfortunately, other changes in Table 4 were not statistically significant apart from the first major column. For the statistically significant pro-poor changes in the concentration indices seen in Tables 4, it emerged that changes in inequality between socioeconomic groups (ΔC_B) are the major contributors to the significant reductions in SAH inequality in South Africa compared to changes in inequality within groups (ΔC_W). About 96.4% of the reduction in socioeconomic inequalities in SAH in South Africa between 2008 and 2012, for instance, is attributed to reductions in inequalities between socioeconomic groups ($\left(\frac{\Delta C_B}{\Delta C}\right)\% = 96.4\%$) (Table 4). Between 2008 and 2010/11, the reduction in socioeconomic inequalities in SAH was entirely (100%) due to reductions in inequality between socioeconomic groups (Table 4). The relative contributions of changes in inequalities within different quintiles of socioeconomic status to changes in the overall within-group component ($\left(\frac{C_{W_k}}{C_W}\right)\%$) are contained in the Appendix.

4. Discussion

A significant socioeconomic gradient exists in self-assessed health among adults in South Africa. Good health is reported more by relatively wealthier adults than their more socioeconomically deprived counterparts, using data from 2008 to 2017. This gradient, interpreted as a pro-rich distribution, is driven mainly by significant inequalities between socioeconomic quintiles, as more adults in wealthier quintiles report better health than those in more deprived quintiles. Although socioeconomic inequalities remained pro-rich between 2008 and 2017, significant reductions have occurred since 2008 as the positive concentration index of SAH declined overall between 2008 and 2017. The decomposition analysis reveals that the decline in pro-rich inequalities in SAH is driven mainly by closing gaps between socioeconomic groups rather than within socioeconomic groups, as the reductions between socioeconomic group inequalities accounted for between 96% and 100% of reductions in overall inequalities in SAH among adults in South Africa. Changes in inequalities within socioeconomic groups were not statistically significant and contributed minimally to SAH inequality reductions. These non-significant changes in socioeconomic inequalities within socioeconomic groups mean that inequalities within groups have remained unchanged over time. However, reductions in overall socioeconomic inequalities in SAH have been driven by closing the gaps between socioeconomic groups, an area that received significant policy attention in the country since the fall of apartheid, with prioritising the health of those from deprived backgrounds (Coovadia et al., 2009). Possible reasons exist for the non-significance of the changes in SAH inequalities within socioeconomic groups. The relatively small changes in the overall concentration indices and the minimal contributions of inequalities within socioeconomic groups to overall inequalities reported in Table 3 could explain this non-significance. Also, people in the same socioeconomic groups tend to live in similar environments, sharing many things in common (Pérez-Stable & Hooper, 2023), including perceiving and reporting similar SAH. While this may be the case, a gradient in SAH was obvious between socioeconomic groupings in South Africa. It is important to note that the non-significance of the contributions of changes within socioeconomic groups to changes in overall inequalities reported in this paper may differ in contexts other than South Africa. Research in other contexts is needed to ascertain differences between countries. Also, while policy is needed to close off the gaps between groups, it is important to continually monitor changes within groups to ensure they do not widen, which the methodology applied in this paper (Ataguba et al., 2023) can be used to monitor.

This paper is the first to apply the Ataguba et al. (2023) methodology to assess changes in socioeconomic inequalities in self-assessed health in South Africa or elsewhere to understand the relative contributions of inequalities within and between socioeconomic groups as drivers of

Table 4
Decomposing changes in socioeconomic inequalities in SAH into between and within group components, South Africa, 2008–2017

		Period 1 (2008)	Period 2 (2010/11)	Period 3 (2012)	Period 4 (2014/15)		Period 1 (2008)	Period 2 (2010/11)	Period 3 (2012)	Period 4 (2014/15)
Period 2 (2010/11)	ΔC_B	−0.0271*** (0.0042)	–	–	–	$\left(\frac{\Delta C_B}{\Delta C}\right)\%$	100.0%	–	–	–
	ΔC_W	0.0000 (0.0010)	–	–	–	$\left(\frac{\Delta C_W}{\Delta C}\right)\%$	0.0%	–	–	–
	ΔC	**−0.0271*** (0.0043)**	–	–	–					
Period 3 (2012)	ΔC_B	−0.0264*** (0.0045)	0.0007 (0.0039)	–	–	$\left(\frac{\Delta C_B}{\Delta C}\right)\%$	96.4%	−233.3%	–	–
	ΔC_W	−0.0010 (0.0010)	−0.0010 (0.0009)	–	–	$\left(\frac{\Delta C_W}{\Delta C}\right)\%$	3.6%	333.3%	–	–
	ΔC	**−0.0274*** (0.0046)**	**−0.0003 (0.0039)**	–	–					
Period 4 (2014/15)	ΔC_B	−0.0254*** (0.0044)	0.0017 (0.0039)	0.0010 (0.0041)	–	$\left(\frac{\Delta C_B}{\Delta C}\right)\%$	96.9%	188.9%	83.3%	–
	ΔC_W	−0.0008 (0.0009)	−0.0008 (0.0008)	0.0002 (0.0009)	–	$\left(\frac{\Delta C_W}{\Delta C}\right)\%$	3.1%	−88.9%	16.7%	–
	ΔC	**−0.0262*** (0.0046)**	**0.0009 (0.0039)**	**0.0012 (0.0042)**	–					
Period 5 (2017)	ΔC_B	−0.0220*** (0.0039)	0.0052 (0.0032)	0.0044 (0.0037)	0.0034 (0.0034)	$\left(\frac{\Delta C_B}{\Delta C}\right)\%$	97.8%	113.0%	89.8%	91.9%
	ΔC_W	−0.0006 (0.0009)	−0.0006 (0.0008)	0.0005 (0.0008)	0.0003 (0.0008)	$\left(\frac{\Delta C_W}{\Delta C}\right)\%$	2.7%	−13.0%	10.2%	8.1%
	ΔC	**−0.0225*** (0.0039)**	**0.0046 (0.0032)**	**0.0049 (0.0037)**	**0.0037 (0.0036)**					

Notes: C_B and C_W represent inequality between and within socioeconomic groups, respectively.
$\Delta C = C^t - C^{t-1}$; $\Delta C_B = C_B^t - C_B^{t-1}$; $\Delta C_W = C_W^t - C_W^{t-1}$
C^t and C^{t-1} represent socioeconomic inequalities in SAH in recent and former periods, respectively. E.g., if C^t represents inequality for period 2, C^{t-1} will be the corresponding inequality for period 1.
C_B^t and C_B^{t-1} represent inequalities in SAH between socioeconomic groups for recent and former periods, respectively.
C_W^t and C_W^{t-1} represent inequalities in SAH within socioeconomic groups for recent and former periods, respectively.
$\Delta C < 0$, $\Delta C_B < 0$ and $\Delta C_W < 0$ represent pro-poor shifts, while $\Delta C > 0$, $\Delta C_B > 0$ and $\Delta C_W > 0$ mean pro-rich shifts or changes (Ataguba *et al.*, 2023). In non-technical terms, a pro-poor shift is when the estimated socioeconomic inequality via the concentration index decreases between two time periods. This means that the shift or change will be negative. When the concentration index estimated for a previous period is less than that estimated for a later period so that the difference between these indices is positive, the result is a pro-rich shift between the two time periods.
Bootstrapped standard errors using 1,000 replications are shown in parentheses.
*, **,*** statistically significant at the 10%, 5% and 1% levels, respectively.

overall inequalities in SAH. While there are no previous findings to compare directly with those in this paper, there is overwhelming evidence from low-to high-income countries that socioeconomic inequalities in SAH are to the disadvantage of individuals from poorer socioeconomic backgrounds (Bartoll-Roca et al., 2022; Gravelle & Sutton, 2003; Hu et al., 2016; Moor et al., 2017; Sözmen et al., 2012; van Doorslaer & Gerdtham, 2003), which is consistent with the findings in this paper. Beyond SAH, a look at its other important dimensions shows similarities in some of the conclusions with international literature. For instance, the socioeconomic gradient reported in this paper is also acknowledged globally (Deaton, 2002) and in South Africa for different disease conditions, including multimorbidity (Ataguba, 2013; Ataguba et al., 2011; Nwosu & Oyenubi, 2021). Additionally, the inverse care law has been demonstrated in South Africa, with the available health services being used more by the wealthier populations in South Africa than the more deprived population with more need for health services (Ataguba & McIntyre, 2013).

In a systematic review, DeSalvo et al. (2006) noted the usefulness of responses to a simple, single-item SAH question used in this current paper. They also summarised that poor self-assessed health had a 2-fold higher mortality risk than being in excellent health, even after adjusting for key covariates like comorbidities, depression and functional and cognitive status. Also, SAH inequalities significantly predicted different income groups' survival inequalities (van Doorslaer & Gerdtham, 2003). Based on the link between SAH and mortality, this paper's findings that the pro-rich socioeconomic inequalities in SAH have reduced means that it should be associated with reductions in mortality and subsequent increases in life expectancy in South Africa. Indeed, South Africa's crude death rate of 13 deaths per 1000 people in 2008 (the highest rate in the past 50 years) declined to 9 per 1000 in 2017/18 (World Bank, 2023). Also, South Africa's average life expectancy at birth increased substantially over the same period, from 56 years in 2008 to 66 years in 2018 (World Bank, 2023). This paper notes that reductions in mortality and improvements in average life expectancy between 2008 and 2017/18 reflect the pro-poor shifts or reductions in the pro-rich socioeconomic inequalities in SAH reported in South Africa because reductions in mortality benefited deprived communities. This paper reports that reductions in inequalities between socioeconomic groups accounted for a substantial share of overall reductions in SAH inequalities in the country. This translates to closing the gap between wealthy and less wealthy individuals and not so much about changes occurring within socioeconomic groupings.

Changes in socioeconomic inequalities in SAH between periods were generally pro-poor shifts (i.e., inequalities reduction). They were only significant when comparing socioeconomic inequalities in SAH between 2008 and other periods (2010/11, 2012, 2014/15, and 2017) (see Table 4). This finding may be explained by the significantly high pro-rich socioeconomic inequalities in SAH in 2008 (concentration index estimated at 0.0327) compared to subsequent periods. While it is not entirely clear what caused the sharp decline in the concentration of good health among wealthier populations, several factors may be at play. Unpacking the factors requires recalling the implicit multidimensional nature of the single-item SAH indicator, which is not only affected by access to health services or health outcomes but encompasses physical and psychological health and other broader social determinants of health.

Because SAH is implicitly multidimensional and not directly observable, it is critical for policy to look into its various possible dimensions to understand and explain the sharp decline in its concentration index from its 2008 value. Regarding general health outcomes, human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) and tuberculosis remained significant contributors to disability-adjusted life years (DALYs) lost in Southern Africa, including South Africa (Bradshaw et al., 2003; Coovadia et al., 2009; Gona et al., 2020) and have potential impacts on self-assessed health through its effects on physical and mental health, among others. The combined impact of HIV/AIDS and tuberculosis, for instance, on population health in South Africa is glaring (World Bank, 2023), and this potentially impacts how people rate their health status. During the Presidency of Mr Thabo Mbekhi (between 1999 and 2008), South Africa experienced significant stagnation and, in some cases, a reversal in national HIV responses with the notion that HIV was not the cause of AIDS. This led to substantial HIV-related mortalities and morbidity in South Africa and a decline in health indicators, especially among people from poorer backgrounds (Coovadia et al., 2009), which may be reflected in people's assessment of their health status. Post 2008, a change in government and the leader of the country's National Department of Health led to significant gains in, for instance, life expectancy in an attempt to reverse previous losses. It is important to highlight that the country's lowest average life expectancy at birth in the past five decades (54 years) was recorded between 2003 and 2005 (World Bank, 2023), which could have continued to decline but for the timely intervention and pressure mounted by different non-governmental stakeholders on the South African government of the time to roll out antiretrovirals (ARVs). Only in August 2003 did the South African Cabinet approve the public roll-out of ARVs, and implementation began in 2004 (Hanefeld, 2010), which contributed substantially to the initial increases in average life expectancy starting from 2006/07. The strong relationship between SAH and health outcomes (DeSalvo et al., 2006) means that increases in life expectancies and improvements in health outcomes could partly account for the significant reduction in health inequalities (measured using SAH) in South Africa between 2008 and subsequent periods. For the social determinants of health that are also related to SAH (Graf & Patrick, 2016), in addition to accessing clean drinking water, which is almost universal, another crucial social determinant of health inequalities is access to good and improved sanitation (Commission on Social Determinants of Health, 2008). In 1993/94, only about half of South Africa's population accessed good sanitation, which increased substantially to nearly 80% by 2008/09 (The Presidency, 2009). By 2018, data from the 2018 General Household Survey indicated that 83% of the population had access to improved sanitation (Statistics South Africa, 2018), signifying that only marginal progress has been made toward accessing improved sanitation since 2009 as substantial progress was made in periods up to 2008.

Over time, reduced pro-rich socioeconomic inequalities in SAH in South Africa mean significant improvements occurred among less wealthy socioeconomic groups. Interestingly, these occurred with improved health indicators like average life expectancy over this period. This is obvious because this paper's analysis results highlight that inequalities within socioeconomic groups were minute and not statistically significant. However, the narrowing of inequalities between socioeconomic groups drives changes in socioeconomic inequalities in SAH. Thus, substantial reductions in health inequalities can continually be achieved in South Africa by prioritising reductions between socioeconomic groups, mainly as this is the primary driver of reductions in socioeconomic inequalities in SAH. This resonates with the need to close the gaps between the poor and rich, prioritise the vulnerable's needs and leave no one behind (United Nations, 2022). Although the single-item SAH indicator used in this paper is implicitly not a specific health condition, it is imperative to highlight that addressing inequalities in SAH requires policies that grapple with its various dimensions. Importantly, as the results of this paper demonstrate, there is a need for policy prioritising more deprived socioeconomic groups to narrow existing gaps and address the major social determinants of health inequalities, including social protection and employment, knowledge and education and housing and infrastructure (Ataguba et al., 2015), and access to quality health services that have been reported in previous studies.

The recent COVID-19 pandemic, for instance, has highlighted the need to pay attention to inequalities in many dimensions, including inequalities in the social determinants of health. Understanding how the pandemic and any major recent events affect health inequalities, including inequalities in SAH between and within socioeconomic groups, are potential areas for future research. While the pathways of influence may vary, the methodology used in this paper provides the tools for investigating the effects of policy changes or any shock (e.g., the COVID-19 pandemic) on health inequalities, unpacking their impact on closing the gaps between socioeconomic groups and reducing overall health inequalities, especially in countries with significant disparities in many social dimensions, including income, health and education.

One of the paper's strengths is using nationally representative datasets of the adult population to show the relative contributions of changes in health inequalities within and between socioeconomic groups to changes in inequalities in SAH in South Africa for the first time. A limitation of the paper is the use of the longitudinal NIDS datasets cross-sectionally because the paper's interest was to understand the contributions of between- or within-socioeconomic groups to changes in health inequalities at a national level. It is important to note that a major challenge with the NIDS dataset was increasing attrition between waves, especially among selected race groups and high-income households (Branson, 2019). The cumulative attrition rate exceeded 50% among some race groups between NIDS waves 1 and 5, leading to "topping up" the sample to ensure nationally representative samples. The NIDS sample weights were adjusted to account for the top-ups, and the processes involved have been detailed elsewhere (Branson & Wittenberg, 2019). To avoid the significant challenge of attrition bias when using the data in ways that are no longer nationally representative, and because the methodology used in this paper does not strictly require longitudinal data, these data have been used in a cross-sectional fashion given that each NIDS wave is nationally representative even with the sample top-ups. It is important to note that the national representativeity of the NIDS data for this study implies the adult population, which logically follows from the national representativeity of the entire survey. Also, this paper uses quintiles for socioeconomic groupings as a popular categorisation used in the literature as opposed to tertiles, quartiles or deciles, for instance. However, sensitivity analysis shows the robustness of results using reasonable socioeconomic groupings. A single-item indicator for SAH was used to represent a multidimensional indicator because an individual is expected to evaluate and internalize many dimensions of their health before responding to the question. While this implicitly represents a multidimensional measure, it may not fully capture all the dimensions, which may require operationalizing multiple questions in a questionnaire across multiple dimensions.

5. Conclusion

With persistently pro-rich socioeconomic inequalities in self-assessed health, relatively deprived socioeconomic groups continually bear a higher burden of poor health in South Africa. This paper shows that while initial reductions occurred between 2008 and 2012, socioeconomic inequalities in self-assessed health increased since 2014/15, evidenced by the increasingly positive concentration indices for SAH. Interestingly, reductions in socioeconomic inequalities in health in South Africa are driven predominantly by reducing inequalities between rather than within socioeconomic groups. This finding, coupled with the significant body of literature documenting the importance of the social determinants of health in attenuating health inequalities, means that addressing the pro-rich health inequalities in South Africa requires policy aimed at reducing health disparities between groups and addressing the major social determinants of health using multisectoral approaches that prioritise socioeconomically deprived individuals to leave no one behind. Based on existing evidence (Ataguba et al., 2015; World Health Organization, 2013), the multisectoral approach should prioritise key sectors driving inequalities in SAH in South Africa, including employment, education, social protection, and urban development and infrastructure. While acknowledging the significant pressure on government resources and fiscal space, an important cross-cutting policy action is increasing the government's budgetary allocations to these key sectors, including health (Ataguba et al., 2015) and monitoring relevant progress indicators to ensure progressive realisation, prioritising deprived socioeconomic groups.

Ethics approval and consent to participate

The study used data freely available at <https://www.datafirst.uct.ac.za/dataportal>, containing no personally identifiable information. There are no ethical issues because this research uses anonymised publicly available data from the National Income Dynamics Study (NIDS).

Consent for publication

Not applicable.

Availability of data and materials

Data are available at https://www.datafirst.uct.ac.za/dataportal, and are accessible after registration on the website.

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Declaration of interest statement

The authors have no conflicts of interest to declare.

Appendix

Table 5
Sample sizes and unweighted summary statistics, South Africa, 2008–2017

	Period 1: 2008	Period 2 (2010/11)	Period 3 (2012)	Period 4 (2014/15)	Period 5 (2017)
Age	13,732 (41.5)	15,152 (40.6)	16,280 (40.7)	20,095 (40.1)	21,303 (40.8)
Household size	13,732 (4.9)	15,152 (5.8)	16,280 (5.4)	20,095 (5.2)	21,303 (5.1)
Self-assessed health (SAH)	10,416 (76.3%)	13,069 (86.4%)	14,051 (86.4%)	17,535 (87.3%)	18,615 (87.5%)
Location					
Urban	6944 (50.6%)	7290 (48.1%)	8301 (51.0%)	10,578 (52.6%)	11,759 (55.2%)
Sex of adult					
Female	8360 (60.9%)	9020 (59.5%)	9897 (60.8%)	11,935 (59.4%)	12,767 (59.9%)
Private health insurance	1570 (11.5%)	1264 (8.8%)	1575 (9.7%)	1862 (9.3%)	2514 (11.8%)
Race					
African	10,624 (77.5%)	12,476 (82.4%)	13,301 (81.7%)	16,598 (82.6%)	16,928 (79.5%)
Coloured	2009 (14.7%)	1978 (13.1%)	2296 (14.1%)	2809 (14.0%)	2869 (13.5%)
Asian	192 (1.4%)	177 (1.2%)	175 (1.1%)	197 (1.0%)	354 (1.7%)
White	875 (6.4%)	517 (3.4%)	508 (3.1%)	490 (2.4%)	1145 (5.4%)
Marital status					
Married or living together	5741 (41.9%)	5482 (36.3%)	5850 (36.0%)	4615 (26.1%)	5126 (27.6%)
Never married	6173 (45.1%)	7888 (52.3%)	8554 (52.6%)	12,333 (69.8%)	12,561 (67.7%)
Widowed or separated	1774 (13.0%)	1725 (11.4%)	1866 (11.5%)	721 (4.1%)	861 (4.6%)
Education					
No formal schooling	2004 (14.6%)	2140 (14.2%)	2015 (12.4%)	774 (4.1%)	1724 (8.1%)
Primary school	3422 (25.0%)	3357 (22.2%)	3412 (21.0%)	3790 (20.1%)	3539 (16.7%)
Secondary school	6632 (48.5%)	7811 (51.8%)	8609 (52.9%)	10,792 (57.1%)	11,564 (54.4%)
Tertiary school	1632 (11.9%)	1782 (11.8%)	2233 (13.7%)	3534 (18.7%)	4426 (20.8%)

Notes: Sample size reported. For the descriptive statistics in parentheses, percentages were reported for binary variables, while means were reported for age and household size.

Table 6
Relative contributions of changes in inequalities within quintiles to overall changes in the within-socioeconomic group inequalities in SAH, South Africa, 20108-2017

		Period 1 (2008)	Period 2 (2010/11)	Period 3 (2012)	Period 4 (2014/15)		Period 1 (2008)	Period 2 (2010/11)	Period 3 (2012)	Period 4 (2014/15)
Period 2 (2010/11)	ΔC_{W_1}	−0.0002 (0.0003)	–	–	–	$\left(\frac{\Delta C_{W_1}}{\Delta C_W}\right)\%$	−200.0%	–	–	–
	ΔC_{W_2}	0.0003 (0.0004)	–	–	–	$\left(\frac{\Delta C_{W_2}}{\Delta C_W}\right)\%$	300.0%	–	–	–
	ΔC_{W_3}	0.0002 (0.0004)	–	–	–	$\left(\frac{\Delta C_{W_3}}{\Delta C_W}\right)\%$	200.0%	–	–	–
	ΔC_{W_4}	0.0000 (0.0005)	–	–	–	$\left(\frac{\Delta C_{W_4}}{\Delta C_W}\right)\%$	0.0%	–	–	–

(*continued on next page*)

Table 6 (*continued*)

		Period 1 (2008)	Period 2 (2010/11)	Period 3 (2012)	Period 4 (2014/15)		Period 1 (2008)	Period 2 (2010/11)	Period 3 (2012)	Period 4 (2014/15)
	ΔC_{W_5}	−0.0002 (0.0004)	–	–	–	$\left(\frac{\Delta C_{W_5}}{\Delta C_W}\right)\%$	−200.0%	–	–	–
Period 3 (2012)	ΔC_{W_1}	0.0004 (0.0003)	0.0006** (0.0002)	–	–	$\left(\frac{\Delta C_{W_1}}{\Delta C_W}\right)\%$	−40.0%	−54.5%	–	–
	ΔC_{W_2}	0.0002 (0.0004)	−0.0001 (0.0003)	–	–	$\left(\frac{\Delta C_{W_2}}{\Delta C_W}\right)\%$	−20.0%	9.1%	–	–
	ΔC_{W_3}	−0.0006 (0.0004)	−0.0008** (0.0003)	–	–	$\left(\frac{\Delta C_{W_3}}{\Delta C_W}\right)\%$	60.0%	72.7%	–	–
	ΔC_{W_4}	−0.0006 (0.0005)	−0.0006 (0.0005)	–	–	$\left(\frac{\Delta C_{W_4}}{\Delta C_W}\right)\%$	60.0%	54.5%	–	–
	ΔC_{W_5}	−0.0004 (0.0005)	−0.0002 (0.0004)	–	–	$\left(\frac{\Delta C_{W_5}}{\Delta C_W}\right)\%$	40.0%	18.2%	–	–
Period 4 (2014/15)	ΔC_{W_1}	0.0002 (0.0003)	0.0004[a] (0.0002)	−0.0001 (0.0003)	–	$\left(\frac{\Delta C_{W_1}}{\Delta C_W}\right)\%$	−22.2%	−50.0%	−50.0%	–
	ΔC_{W_2}	0.0001 (0.0004)	−0.0001 (0.0003)	0.0000 (0.0003)	–	$\left(\frac{\Delta C_{W_2}}{\Delta C_W}\right)\%$	−11.1%	12.5%	0.0%	–
	ΔC_{W_3}	−0.0001 (0.0004)	−0.0003 (0.0003)	0.0004 (0.0003)	–	$\left(\frac{\Delta C_{W_3}}{\Delta C_W}\right)\%$	11.1%	37.5%	200.0%	–
	ΔC_{W_4}	−0.0003 (0.0005)	−0.0003 (0.0004)	0.0003 (0.0004)	–	$\left(\frac{\Delta C_{W_4}}{\Delta C_W}\right)\%$	33.3%	37.5%	150.0%	–
	ΔC_{W_5}	−0.0008 (0.0005)	−0.0005 (0.0004)	−0.0004 (0.0005)	–	$\left(\frac{\Delta C_{W_5}}{\Delta C_W}\right)\%$	88.9%	62.5%	−200.0%	–
Period 5 (2017)	ΔC_{W_1}	0.0005 (0.0003)	0.0007*** (0.0003)	0.0001 (0.0003)	0.0002 (0.0003)	$\left(\frac{\Delta C_{W_1}}{\Delta C_W}\right)\%$	−125.0%	−140.0%	25.0%	100.0%
	ΔC_{W_2}	0.0004 (0.0004)	0.0001 (0.0003)	0.0002 (0.0003)	0.0002 (0.0003)	$\left(\frac{\Delta C_{W_2}}{\Delta C_W}\right)\%$	−100.0%	−20.0%	50.0%	100.0%
	ΔC_{W_3}	−0.0003 (0.0004)	−0.0005[a] (0.0003)	0.0002 (0.0003)	−0.0002 (0.0003)	$\left(\frac{\Delta C_{W_3}}{\Delta C_W}\right)\%$	75.0%	100.0%	50.0%	−100.0%
	ΔC_{W_4}	−0.0004 (0.0004)	−0.0004 (0.0004)	0.0001 (0.0004)	−0.0001 (0.0004)	$\left(\frac{\Delta C_{W_4}}{\Delta C_W}\right)\%$	100.0%	80.0%	25.0%	−50.0%
	ΔC_{W_5}	−0.0006 (0.0004)	−0.0004 (0.0003)	−0.0002 (0.0004)	0.0001 (0.0004)	$\left(\frac{\Delta C_{W_5}}{\Delta C_W}\right)\%$	150.0%	80.0%	−50.0%	50.0%

Notes: $\Delta C_{W_k} = C_{W_k}^{t} - C_{W_k}^{t-1}$

Bootstrapped standard errors in parenthesis.

[a] ,**,*** statistically significant at the 10%, 5% and 1% levels, respectively.

Data availability

Data are available at https://www.datafirst.uct.ac.za/dataportal, and are accessible after registration on the website.

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