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The hidden toll: Assessing the economic burden of pentazocine dependence on sickle cell disease patients in Nsukka local government Area, Enugu State, Nigeria

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Abstract

Background: Pentazocine (PTZ) is commonly prescribed for the management of acute and chronic pain in patients with Sickle Cell Disease (SCD). However, prolonged and unsupervised usage can lead to dependence, posing immediate health risks and contributing to escalated healthcare expenses, decreased productivity, and societal repercussions affecting families and communities. This research aims to evaluate the financial burden incurred by SCD patients frequenting pharmacies due to pentazocine dependence in the Nsukka Local Government Area of Enugu State.

Methods: Data regarding patterns of pentazocine utilization and the impact of dependence-related complications on labor force participation were collected using self-reported cost-of-illness instruments across 25 selected pharmacy stores in Nsukka, Enugu State. Direct medical and non-medical costs were estimated by summing the various out-of-pocket expenses, while the indirect cost was evaluated utilizing the human capital theory. All analyses were conducted using Microsoft Excel and IBM Statistical Package for Social Sciences (SPSS®) version 23 software.

Results: The average direct cost attributed to pentazocine dependence was estimated at NGN 116,587.71 (USD 143), while the average indirect monetary equivalent of time lost due to dependence or its complications was assessed at NGN 17,415.06 (USD 21.37), resulting in an average cost of pentazocine dependence borne by SCD patients in Nsukka, Enugu State, of 134,002.77 (USD 164.42). The projected annual cost of dependence was estimated at NGN 422,156,564 (USD 517,983.52).

Conclusion: The study demonstrated significant financial implications for patients due to pentazocine dependence, constituting 87% of the direct cost and 13% of the indirect cost of the dependence.

Keywords: Direct costs; Human Capital Approach; Indirect Costs; Pentazocine; Dependence; Sickle Cell Disease

1. Introduction

Sickle cell disease (SCD), a congenital blood disorder, poses a significant public health concern, particularly in Sub-Saharan Africa. Globally, SCD affects an estimated 50 million people, with Africa accounting for around 85%. Nigeria is

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recognized as the epicenter of SCD, as it affects an estimated 4-6 million people, with one in every four Nigerians bearing the sickle cell trait [1]. Every year, around 300,000 new SCD cases are identified worldwide, with Sub-Saharan Africa accounting for approximately 75% of these cases [2]. Notably, Nigeria accounts for 100,000–150,000 babies with SCD each year, accounting for 33% of the global burden [3]. As a result, Nigeria plays a critical role in the global epidemiology of SCD.

The fundamental pathophysiology of sickle cell disease is primarily characterized by deoxygenation-induced polymerization of erythrocytes, which results in their distortion and subsequent hemolysis, culminating in a variety of clinical manifestations, most notably acute pain crises and the development of anemia [4]. The occurrence of vaso-occlusive crises is a defining feature of sickle cell disease, and it is the primary reason for frequent hospital visits for people with this condition [5]. Elander *et al.*, (2003) found that pain-related symptoms accounted for a considerable 88% of all reported symptoms in a study of sickle cell disease patients [6].

Pain management during sickle cell crises is a critical component of care [7]. Typically, the choice of analgesia involves a combination of opioids and non-steroidal anti-inflammatory drugs [8]. In cases of sickle cell disease (SCD), pentazocine (PTZ) is frequently prescribed to manage both acute and chronic pain, effectively alleviating pain, improving functionality, and reducing hospitalizations for most SCD patients [7,9]. Pentazocine is a synthetic opioid analgesic, and has a dual receptor profile, acting as a partial agonist at the μ -receptor and a kappa agonist [10]. It offers both analgesic and euphoric effects, with a rapid onset of action (within 10-20 minutes) and a duration of 2-4 hours, making it well-suited for managing sickle cell-related pain [10, 11].

However, prolonged, unsupervised use of opioids, including pentazocine, can lead to opioid dependence, a complex medical condition requiring long-term treatment. The World Health Organization (WHO) has excluded pentazocine from its pain control guidelines due to its potential for dependence and other adverse effects [12, 13, 14].

In Nigeria, the availability and access to controlled medications are regulated by national legislation and policies designed to promote responsible use and protect patients [15]. Notably, pentazocine is categorized as a psychotropic substance listed under Schedule III of nationally controlled drugs. Despite strict drug control measures, pentazocine dependence is a concerning trend within the SCD population, impacting their social, economic, and physical well-being. It is marked by intense drug cravings, excessive sweating, body pains, and poor academic performance [16, 17]. This dependence can lead to a range of societal problems, including loss of productivity, truancy, involvement in criminal activities to support cravings, and increased health risks due to the use of contaminated injection equipment [17, 18]. Beyond immediate health risks, the economic burden of pentazocine dependence is evident, contributing to increased healthcare costs, reduced productivity, and societal implications affecting families and communities.

Cost of illness studies estimate the monetary burden of diseases on society, providing valuable insights for policymakers [19, 20]. To enhance comparability across studies, guidelines have been developed, emphasizing key reporting concepts. These concepts include the study perspective, cost estimation approach, and cost types. The study perspective can vary, such as societal, healthcare system, government, study participants and their families, or a third-party payer's viewpoint [20, 21].

The approach for cost estimation may adopt a prevalence or lifetime incidence-based method, with costs categorized as direct, indirect, or intangible [22, 23]. Direct costs encompass expenses directly linked to the illness [23, 24] and can be further classified as medical or non-medical costs [22, 23]. Indirect costs represent the value of lost production due to reduced working time caused by the illness [25], while intangible costs include psychosocial elements like pain and suffering [22, 25]. In addition to quantifying disease burden in monetary terms, cost of illness studies serve as valuable tools for informing decision-making by policymakers.

Several studies have explored the prevalence of pentazocine dependence among SCD patients in Nigeria. Ahmed *et al.*, (2001) reported a prevalence of 17.8% of opiate dependence among SCD patients in Maiduguri, North-East Nigeria, with a male preponderance [26]. Similarly, Mabayoje *et al.*, (2015) reported an incidence of less than 10% in South-West Nigeria [27]. Iheanacho *et al.*, (2015) reported a prevalence of 18.2% with a male preponderance [18]. However, there is a noticeable lack of studies focusing on the economic cost associated with pentazocine dependence, especially among individuals obtaining these medications from community pharmacies. Therefore, this study aims to fill this knowledge gap and provide a more comprehensive understanding of the issue, which can inform future interventions and policies.

2. Material and methods

2.1. Study Perspective

This study focuses on assessing the economic costs of pentazocine dependence and its associated complications from the perspective of the patients.

2.2. Study Design and Setting

The study employed a cross-sectional descriptive study design conducted among sickle cell patients procuring pentazocine from community pharmacies in Nsukka Local Government, Enugu State. This choice was justified by the need to estimate the "cost-of-illness," which is a descriptive economic method commonly used to evaluate the cost of a specific disease [28]. The cross-sectional descriptive survey design was deemed appropriate as it facilitates data collection at a single point in time, offering insights into the prevalence and characteristics of pentazocine dependence among Sickle Cell Disease (SCD) patients patronizing community pharmacies in the Nsukka Local Government area of Enugu State.

2.3. Sampling

Pharmacy Selection: A stratified random sampling technique was employed to select a total of 25 community pharmacies from diverse locations in the city to ensure representation from various areas.

Participant Selection: Within each selected pharmacy, at least two SCD patients with an established history of pentazocine dependence based on the criteria for substance use dependence in ICD-10 [29] were recruited for the study. Convenience sampling was utilized to ensure that patients visiting the pharmacy during the study period were invited to participate.

2.4. Study Instruments

The Cost of Illness (COI) instrument, adapted from Ismail *et al.* 2023 [30], was employed to estimate the cost implications of pentazocine dependence among SCD patients. The instrument comprised three sections:

- Subsection one collected socio-demographic data of patients.
- Section two gathered relevant information concerning pentazocine dependence.
- Section three encompassed three subsections containing pertinent variables such as patients' daily pentazocine consumption, the frequency of hospital visits for dependence-related treatment, the number of days spent on admission and associated costs (if admitted), transportation costs, registration fees, laboratory tests, drug expenses, food costs per hospital visit, the number of working hours when not ill and when sick, and health insurance registration status. These variables were used to estimate the cost of treating dependence from the patients' perspective.

2.5. Data Collection

A total of fifty-five SCD patients with an established history of pentazocine dependence, who purchased pentazocine with or without prescriptions during the study period in the selected community pharmacies, consented to participate in the study. Patients filled out self-reported instruments. Data collection took place between March and September 2023.

2.6. Economic Burden Analyses

2.6.1. Cost Evaluation

The study assessed the economic burden incurred by SCD patients due to pentazocine dependence in Nsukka, Enugu State. Descriptive statistics, including frequency, percentage distributions, mean, standard deviations, median, and interquartile range (IQR), were presented for categorical and continuous variables. These were used to estimate the direct and indirect cost burdens of pentazocine dependence on SCD patients. All data were managed and analyzed using Microsoft Excel (version 2007) and IBM-SPSS® (version 23) software.

Direct Cost

- Direct Financial Cost Variables

The direct financial cost were estimated using the following variables:

- Average cost of purchasing pentazocine per month.
- Patients' registration costs.
- Laboratory diagnosis costs.
- Cost of drugs (medical costs).
- Costs of transportation, food, and accommodation if admitted (non-medical costs).
- Calculation of Direct Cost

The estimated direct financial cost of pentazocine dependence was calculated as follows:

$$\text{Direct cost} = \text{Medical cost} + \text{Non-medical cost} \dots\dots\dots(i)$$

Medical cost = Average cost of purchasing pentazocine per month + Average amount spent on treatment for at least one episode of pentazocine dependence complications, including Patients' registration cost, Laboratory diagnosis cost, and Cost of drugs.

Non-medical cost = Transportation cost + Feeding cost + Accommodation cost.

Indirect Costs (Opportunity Costs)

The indirect monetary cost (opportunity cost due to loss of productive time during the ailment) was estimated using the Human Capital Theory (HCT) approach [31, 32]. In the valuation of financial losses by patients due to pentazocine dependence, the average time loss (days) due to complications was calculated.

- Calculation of Indirect Cost

The opportunity cost (P) due to pentazocine dependence was calculated based on Equation below:

$$\text{Indirect cost (P)} = \mu (P_1 + P_2 + P_3 \dots + P_n) \dots\dots\dots(ii)$$

Where P₁ = waiting time at the PHC facilities, P₂ = decreased working time per day due to the ailment, P₃ = time lost due to incapacitation, and P_n = other opportunity costs due to the ailment. μ represents the average wage of the respondents.

2.7. Assumptions

The following assumptions were made during the calculations:

- Government working hours start from 8 am to 4 pm (8 h) per day.
- Exchange rate: NGN 815.00 = 1 USD (based on Nigerian central bank foreign exchange rate of September 2023).

2.8. Total Economic Burden

The total economic burden on patients due to pentazocine dependence was estimated by summing the direct cost (medical and non-medical) and the indirect costs as follows:

$$\text{The financial cost of dependence} = \text{Direct costs} + \text{Indirect costs} \dots\dots\dots(iii)$$

2.9. Projected annual economic burden due to pentazocine dependence among sickle cell patients

To determine the yearly economic burden resulting from pentazocine dependence and its associated complications, a baseline sickle cell disease prevalence rate of 0.03 was used. This estimate was derived from a survey on pentazocine dependence and opioid use in adult sickle cell anemia patients in Enugu, which indicated a prevalence rate of 0.03 [33]. Additionally, the population of Nsukka, estimated at 128,586 based on the most recent Nigerian census [35], was used when calculating the annual financial cost of pentazocine dependence among patients in the study area.

$$\text{Projected economic burden} = \text{Mean cost} \times \text{population} \times \text{prevalence rate} \dots\dots\dots(iv)$$

2.10. Ethical Statement

Informed consent was obtained from both the pharmacists and SCD patients. Participation was voluntary, and the confidentiality of all respondents was ensured during and after the study.

3. Results

3.1. Sociodemographic Characteristics of Study Participants

Fifty-five individuals diagnosed with sickle cell disease (SCD) with an established history of pentazocine dependence participated in this study. The median age of the participants was 27 years, with a male-to-female ratio of approximately 6:1. A significant majority of the subjects were single (85.5%), while a smaller proportion were married (18.2%). Notably, a large percentage of the participants (83.6%) had received education beyond the secondary level. Employment distribution among the subjects revealed that 67.3% were employed, with smaller proportions being unemployed (9.1%), self-employed (12.7%), or students (10.9%) (Table 1).

Table 1 Socio-demographic parameter of SCD patients (N = 55)

Variables	N	%
Age		
< 20 years	5	9.1
21 – 30 years	26	47.3
31 – 40 years	16	29.1
41 – 50 years	8	14.5
Median age	27 years	
Gender		
Male	47	85.5
Female	8	14.5
Marital status		
Single	42	76.4
Married	10	18.2
Divorced	3	5.4
Educational level		
Secondary school	9	16.4
College or higher	46	83.6
Employment status		
Employed	37	67.3
Unemployed	5	9.1
Student	6	10.9
Self employed	7	12.7
Average monthly salary	NGN 50, 034	

3.2. Details of Participants' Pentazocine Usage

The majority of the participants (90.9%) had HbSS type sickle cell disease, and approximately 67.3% had been living with SCD for 11 to 15 years, with only 1.8% living with the disease for over 20 years. The utilization of pentazocine varied among the participants. A considerable percentage (72.7%) reported that they had been receiving pentazocine, either self-administered or administered by someone else, for more than 5 years. All participants consumed pentazocine within the last 30 days of the study, with approximately 74.5% reporting daily usage. On average, around 27.3% of participants reported using as much as 5 ampoules (150 mg) of pentazocine at a time, while approximately 60% reported consuming 6 or more ampoules per day.

Table 2 Data on Sickle Cell Disease and Pentazocine use (N = 55)

Variable	N	%
Type of SCD		
HbSS	50	90.9
HbSc	5	9.1
Year of SCD diagnosis		
≤ 10 years	12	21.8
11 – 15 years	37	67.3
16 – 20 years	5	9.1
> 20 years	1	1.8
Length of Pentazocine usage		
≤ 2 years	1	1.8
2 – 5 years	14	25.5
> 5 years	40	72.7
Used pentazocine in the last 30 days		
Yes	55	100
No	0	0
Frequency of pentazocine use		
Daily	41	74.5
Weekly	13	23.6
Monthly	0	0
Only in painful crises	1	1.8
Average dose of Pentazocine use per time		
1 ampoules	5	9.1
2 – 3 ampoules	28	50.9
4 – 5 ampoules	15	27.3
> 5 years	7	12.7
Maximum dose of pentazocine per day		
1 – 2 ampoules	3	5.5
3 – 5 ampoules	19	34.5
> 5 ampoules	33	60

3.3. Economic burden of pentazocine dependence

The economic burden of pentazocine dependence among sickle cell disease subjects in Nsukka, Enugu State, was assessed in two distinct categories:

- Average cost of pentazocine dependence per day
- Average costs associated with managing complications arising from pentazocine dependence

3.3.1. Average cost of pentazocine dependence per day

This is evaluated in two categories:

- Average cost of purchasing pentazocine per day
- Average extra cost associated with pentazocine purchase and administration per day

Average cost of purchasing pentazocine per day

The study participants exhibited a mean daily pentazocine injection dose of 5.6 ampoules, with 6 ampoules being the median (ranging from 1 to 10 ampoules). The average price per ampoule of pentazocine was calculated to be NGN 385 ± 65.0 (USD 0.47 ± 0.08), with a median price of NGN 400 (USD 0.49) per ampoule. Consequently, the mean daily expenditure on pentazocine procurement was estimated to be NGN 2144.5 ± 65.0 (USD 2.63 ± 0.08), while the median expenditure was NGN 2100 (USD 2.58) (500-4000).

Average extra cost associated with pentazocine purchase and administration per day

This category comprises the following subdivisions:

- Average cost of transportation for purchasing pentazocine per day = NGN 431.8 ± 254 (USD 0.53 ± 0.3)
- Average service charge for pentazocine administration per day = NGN 327.27 ± 450 (USD 0.4 ± 0.6)
- Average miscellaneous costs related to pentazocine usage per day = NGN 63.64 ± 115.7 (USD 0.08 ± 0.14)

3.3.2. Average costs associated with managing complications arising from pentazocine dependence

Among the participants in our study, the most prevalent complications linked to pentazocine dependence were abscesses (67.7%), healed scars (64.5%), and chronic ulcers (51.6%). Notably, 56.4% of the participants reported experiencing one or more complications resulting from pentazocine overuse. Prior to the study, 90.3% of those who has had one or more pentazocine related complications had been previously hospitalized or admitted to a healthcare facility, with lengths of stay ranging from 0.5 to 10 days. The average duration of hospitalization was 124.8 hours, with the majority (46.4%) requiring admission for 120 hours or more. Approximately 32.2% spent between 25 to 72 hours, while 14.3% spent between 73 to 120 hours in healthcare facilities, contingent on the severity of their conditions.

Before experiencing complications, participants reported an average daily working duration of 7.6 ± 1.02 hours. A majority (70.5%) worked between 7 to 8 hours, while 15.9% worked between 4 to 6 hours. Following the onset of complications, the mean daily working hours decreased to 2.9 ± 1.34, with a significant portion (72.7%) working less than 3 hours per day, and 20.5% working between 4 to 6 hours.

In addition to the indirect costs incurred by patients in terms of lost time due to pentazocine-related complications, participants also expended varying amounts of money (mean ± SD) to access treatment in hospitals and other healthcare settings. This included expenses for transportation (NGN 2151.52 ± 1306; USD 2.64 ± 1.6), registration (NGN 2862.5 ± 886; USD 3.51 ± 1.1), laboratory services (NGN 8200 ± 2500; USD 10.1 ± 3.1), purchase of prescribed drugs (NGN 12606.5 ± 5465; USD 17.19 ± 6.74), food (NGN 2354.3; USD 2.89), psychotherapy consultation (NGN 11000 ± 4000; USD 13.5 ± 4.9), cost of psychological therapy (NGN 44000 ± 6000; USD 53.99 ± 7.4), and inpatient admission (NGN 30610 ± 7800; USD 37.56 ± 9.57). These collectively represent both the direct medical and non-medical financial burdens associated with pentazocine dependence. Notably, approximately 25.5% of the study population were beneficiaries of health-related insurance schemes. The detailed payment distribution is presented in Table 3.

Table 3 Frequency distribution of patient's cost variables for pentazocine dependence (N = 55)

Variables	n (%)	Descriptive statistics
Cost of pentazocine purchase/day		
Mean (±SD)		2144.5 ± 65
Median (IQR)		2100
Minimum – Maximum		500 – 4000
≤ NGN 1000	5 (9.1)	
NGN 1100 – 2000	20 (36.4)	

NGN 2100 – 3000	20 (36.4)	
> NGN 3000	10 (18.1)	
Extra cost on transport to procure pentazocine/day		
Mean (\pm SD)		431.8 \pm 254
Median (IQR)		300
Minimum – Maximum		0 – 1500
\leq NGN 500	43 (78.2)	
NGN 600 – 1000	9 (16.4)	
> NGN 1000	3 (5.4)	
Extra cost on service charge to administer Pentazocine/day		
Mean (\pm SD)		327.27 \pm 450
Median (IQR)		0
Minimum – Maximum		0 – 2000
\leq NGN 500	44 (80)	
NGN 600 – 1000	6 (10.9)	
> NGN 1000	5 (9.1)	
Miscellaneous expenses on pentazocine procurement or administration/day		
Mean (\pm SD)		63.64 \pm 115.7
Median (IQR)		0
Minimum – Maximum		0 – 1000
\leq NGN 500	53 (96.4)	
NGN 600 – 1000	2 (3.6)	
Ever had Pentazocine complications?		
Yes	31 (56.4)	
No	24 (43.4)	
*Complications experienced		
Chronic ulcer	16 (51.6)	
Healed scar	20 (64.5)	
Induration/woodiness	15 (48.4)	
Abscess/wound	21 (67.7)	
Fainting	4 (12.9)	
DVT	4 (12.9)	
Fainting	2 (6.5)	
Vascular injury	2 (6.5)	
Nausea/vomiting	18(58.1)	
Leg swelling	11 (35.5)	
Ankyloses	3 (9.7)	
Others	1 (3.2)	

Number of hospital/clinic visits for pentazocine complications in the past one year (days)		
Mean (\pm SD)		2.9 \pm 1.6
Median (IQR)		2
Minimum – Maximum		0 – 8
Have never	3 (9.7)	
1 – 2 times	13 (41.9)	
3 – 4 times	8 (25.8)	
> 4 times	7 (22.6)	
Ever been admitted due to complications		
Yes	28 (90.3)	
No	3 (9.7)	
Number of days on admission (Mean \pm SD)		
\leq 1 day	13 (46.4)	
1 – 2 days	7 (25)	
> 2 days	8 (28.6)	
Total time spent on admission (hours)		
Mean (\pm SD)		124.8 \pm 2.1
Median (IQR)		120
Minimum – Maximum		24 – 240
\leq 24 hours	2 (7.1)	
25 – 72 hours	9 (32.2)	
73 – 120 hours	4 (14.3)	
> 120 hours	13 (46.4)	
Transportation/visit cost to the hospital/health care facility (NGN)		
Mean (\pm SD)		2151.5 \pm 1306
Median (IQR)		1900
Minimum – Maximum		300 – 6000
\leq NGN 1000	11 (35.5)	
NGN 1100 – 3000	14 (45.2)	
> NGN 3000	6 (19.3)	
Registration cost before accessing the hospital/health care facility (NGN)		
Mean (\pm SD)		2862.5 \pm 886
Median (IQR)		3000
Minimum – Maximum		500 – 5000
\leq NGN 500	2 (7.2)	
NGN 1000 – 3000	13 (46.4)	
> NGN 3000	13 (46.4)	

Any laboratory tests done?		
Yes	16 (57.1)	
No	12 (42.9)	
Cost of laboratory test (NGN)		
Mean (\pm SD)		8200 \pm 2500
Median (IQR)		8000
Minimum - Maximum		3000 - 15000
\leq NGN 5000	3 (18.8)	
NGN 5100 - 10000	8 (50)	
> NGN 10000	5 (31.2)	
Cost of prescribed drugs (NGN)		
Mean (\pm SD)		12606.5 \pm 5465
Median (IQR)		11900
Minimum - Maximum		4000 - 35000
\leq NGN 10000	11 (35.4)	
NGN 11000 - 20000	16 (51.6)	
NGN 21000- 30000	2 (6.5)	
> NGN 30000	2 (6.5)	
Any psychological therapy?		
Yes	2 (6.5)	
No	29 (93.5)	
Cost of consultation for psychotherapy (NGN)		
Mean (\pm SD)		11000 \pm 4000
Median (IQR)		11000
Minimum - Maximum		7000 -15000
\leq NGN 10000	1 (50)	
> NGN 10000	1 (50)	
Cost of psychotherapy (NGN)		
Mean (\pm SD)		44000 \pm 6000
Median (IQR)		44000
Minimum - Maximum		38000 -50000
NGN 20000 - 50000	1 (50)	
> NGN 50000	1 (50)	
Food cost during visit to hospital (NGN)		
Mean (\pm SD)		2190 \pm 950.6
Median (IQR)		2000
Minimum - Maximum		1000 - 5500
\leq NGN 1000	11 (35.5)	

NGN 1100 – 5000	19 (61.3)	
> NGN 5000	1 (3.2)	
In-patient admission cost (NGN)		
Mean (\pm SD)		30610 \pm 7800
Median (IQR)		31950
Minimum – Maximum		6000 – 50 000
\leq NGN 10000	2 (7.2)	
NGN 11000 – 20000	3 (10.7)	
NGN 21000 – 30000	5 (17.8)	
> NGN 30000	18 (64.3)	
Number of hours worked per day before complications and admission (hours)		
Mean (\pm SD)		7.6 \pm 1.02
Median (IQR)		8
Minimum – Maximum		4 – 12
\leq 3 hours	0	
4 – 6 hours	7 (15.9)	
7-8 hours	31 (70.5)	
> 8 hours	6 (13.6)	
Number of hours worked per day after complications and admission (hours)		
Mean (\pm SD)		2.9 \pm 1.34
Median (IQR)		2.5
Minimum – Maximum		0 – 8
\leq 3 hours	32 (72.7)	
4 – 6 hours	9 (20.5)	
7-8 hours	3 (6.8)	
> 8 hours	0	
Registered with any health-related insurance policy/scheme		
Yes	14 (25.5)	
No	41 (74.5)	
If registered, it covered		
Healthcare costs	14 (25.5)	
Income protection	1 (1.8)	
Any others	0	

* Multiple answer applies

3.4. Direct Cost

3.4.1. Direct medical cost for patients

The financial implications of pentazocine dependence were substantial, with the purchase of PTZ constituting 25.3% of the total direct medical costs associated with pentazocine dependence within the study population, amounting to NGN

117,947.5 (USD 144.72). The mean cost per individual for pentazocine purchases was estimated to be NGN 2144.5 (USD 2.63). Notably, the administration cost for pentazocine also made a significant contribution, with a total expenditure of NGN 17,999.5 (USD 22.1) for the study population. Furthermore, the initial registration cost for patients seeking treatment was noteworthy, with the study population collectively paying a total of NGN 80,150 (USD 98.34), equating to 12.9% of the study population. On average, each patient incurred a patient registration cost of NGN 2862.5 (USD 3.51) before receiving treatment at the hospital/clinic. Additionally, the average cost for laboratory services per patient was NGN 8,200 (USD 10.1). It is noteworthy that 12.9% of patients also paid an average of NGN 12,606.5 (USD 15.47) per drug prescription to address complications associated with pentazocine dependence. Psychotherapy consultations and associated costs were relatively minimal, representing a minor fraction (0.9%) of the total medical expenditure. The average cost for psychotherapy consultations was NGN 44,000 (USD 53.99), with a corresponding average cost of NGN 30,600 (USD 37.55) for the treatment itself. With regards to the treatment of their pentazocine dependence and its associated complications, 12.9% of the patients were admitted, resulting in a cumulative in-patient admission cost of NGN 857,000 (USD 1051.53). (Table 4).

Table 4 Average direct medical costs per case of pentazocine dependence in Nsukka Local Government in Naira (NGN/USD)

N = 55					
Variables	Frequency	Percentage	Total cost for study population NGN(USD)	Mean cost NGN (USD)	Standard deviation NGN (USD)
cos on purchase of PTZ	55	25.3	117, 947.5 (144.7)	2, 144.5 (2.63)	65 (0.08)
PTZ administration cost	55	25.3	17, 999.85 (22.1)	327.27 (0.4)	450 (0.55)
Registration	28	12.9	80, 150 (98.34)	2, 862.5 (3.51)	856 (1.05)
Laboratory	16	7.4	131, 200 (160.98)	8, 200 (10.0)	2500 (3.07)
Drugs	31	14.4	390, 801.5 (479.5)	12, 606.5(15.4)	5465 (6.7)
Psychotherapy consultation	2	0.9	22, 000 (26.99)	11, 000 (13.50)	4000 (4.91)
Psychotherapy cost	2	0.9	88, 000 (107.97)	44, 000 (53.99)	6000 (7.36)
In-patient admission	28	12.9	857, 080 (1051.53)	30, 610 (37.56)	7800 (9.57)
Total	217	100	1, 705, 178.85 (2, 092.2)	111, 750.77 (137.1)	4328.6 (5.3)

3.4.2. Direct non-medical costs

Out of the 55 participants involved in the study, 32% resorted to various means of transportation to obtain pentazocine, contributing to a total expenditure of NGN 23,749 (USD 29.1) for the study population. The total cost of transportation to and from the hospital or clinic for the treatment of pentazocine-related complications amounted to NGN 66,696.5 (USD 81.83), averaging NGN 2,151.5 (USD 2.64) per patient. Additionally, during hospital visits or stays, an average of NGN 2,190 (USD 2.69) was expended on food by 18% of the patients. Moreover, 32% of the sickle cell disease (SCD) patients incurred an average cost of NGN 63.64 (USD 0.08) for miscellaneous expenses, such as tipping pharmacists or their assistants in a bid to purchase PTZ. (Table 5).

Table 5 Average direct non-medical costs per case of pentazocine dependence in Nsukka Local Government in Naira (NGN/USD)

N = 55					
Variables	Frequency	Percentage	Total cost for study population NGN(USD)	Mean cost NGN (USD)	Standard deviation NGN (USD)
Transport to procure PTZ	55	32	23, 749 (29.1)	431.8 (0.53)	254 (0.31)
Miscellaneous expenses	55	32	3500.2 (4.29)	63.64 (0.08)	115.7 (0.14)
Transport to Hospital	31	18	66, 696.5 (81.83)	2, 151.5 (2.64)	1306 (1.60)
Food	31	18	67, 890 (83.3)	2, 190 (2.69)	950.6 (1.17)
Total	172	100	161, 835.7 (198.57)	4, 836.94 (5.93)	2626.3 (3.2)

3.4.3. Total direct cost incurred per patient for pentazocine dependence and related complications

The average financial cost of pentazocine dependence and treatment of its associated complications (direct medical and non-medical costs) by SCD patients patronizing community pharmacies in Nsukka Local Government of Enugu state was estimated to be NGN 116, 587.71 (USD 143) while the total cost among the study population was NGN 1, 867, 228.7 (USD 2291.1). Out of this, 55.8% represented direct medical costs, whereas 44.2% represented direct non-medical costs experienced by patients as a result of their dependence (Table 6).

Table 6 Direct average and total costs per case of pentazocine dependence in Nsukka Local Government in Naira (NGN/USD)

N = 55					
Variables	Frequency	Percentage	Total cost for study population NGN(USD)	Mean cost NGN (USD)	Standard deviation NGN (USD)
Direct medical cost	217	55.8	1, 705, 178.85 (2092.2)	111, 750.77 (137.1)	4328.6 (5.3)
Direct non-medical cost	172	44.2	161, 835.7 (198.57)	4, 836.94 (5.93)	2626.3 (3.2)
Total	389	100	1, 867, 228.7 (2291.1)	116, 587.71 (143)	5063.1 (6.2)

3.5. Indirect Costs of pentazocine dependence on SCD Patients.

Table 7 presents the average time lost by patients due to pentazocine dependence and its associated complications, along with the financial burden borne by the patients.

Table 7 Average time lost (days) and money equivalence by SCD patients due to pentazocine dependence in Nsukka Local Government in Naira (NGN/USD)

N = 55				
Variables	Mean time lost \pm SD Days	Total money equivalence(NGN/USD)	Mean money equivalence (NGN/USD)	Standard deviation(NGN/USD)
Waiting time at hospital/clinic(days)	5.2 \pm 0.09	461, 604 (566.4)	8, 392.8 (10.3)	4.95 (0.6)
Decrease in working time (days)	0.19 \pm 0.01	16, 866.3 (20.7)	306.66 (0.38)	0.55
Time loss due to incapacitation(days)	5.4 \pm 3.5	479, 358 (588.2)	8, 715.6 (10.69)	192.5 (0.24)
Total	10.79	957, 828.3(1175.3)	17, 415.06 (21.37)	111.18 (0.14)

3.6. Economic burden of pentazocine dependence and its associated complications on SCD patients

The average direct cost borne by SCD patients in the study area on pentazocine dependence and its related complications was estimated to be NGN 116, 587.71 (USD 143), which exceeded the average indirect cost due to dependence (NGN 17,415.06/USD 21.37) by more than six fold as summarized in Table 8.

Table 8 Economic burden per case of pentazocine dependence per patient and study population in Nsukka Local Government in Naira (NGN/USD)

N = 55			
	Total cost for study population	Mean cost	Standard deviation
Variables	NGN/USD	NGN/USD	NGN/USD
Direct cost	1, 867, 228.7 (2291.1)	116, 587.71 (143)	5063.1 (6.2)
Indirect cost	957, 828.3(1175.3)	17, 415.06 (21.37)	111.18 (0.14)
Total	2, 825, 057 (3466.33)	134, 002.77 (164.42)	3581.02 (4.39)

3.7. Projected annual economic burden due to pentazocine dependence

The total annual financial cost was estimated to be NGN 422,156,564 (USD 517,983.52), with direct costs accounting for 87% and indirect costs borne by patients making up the remaining 13%, as shown in Table 9.

Table 9 Projected annual economic burden due to pentazocine dependence on patients in Nsukka Local Government (in Naira) (NGN) (Nigeria currency/USD)

N = 55		
Variables	NGN	USD
Direct cost	367, 292, 908	450, 666.15
Indirect cost	54, 863, 656.2	67, 317.37
Total	422, 156, 564	517, 983.52

4. Discussion

The cost of illness (COI) studies are indispensable for comprehensively understanding the economic impact of diseases [34, 36]. This study employs a prevalence-based and "bottom-up" approach to estimate the financial burden of pentazocine dependence among sickle cell disease (SCD) patients in Nsukka, Enugu State. The findings shed light on the

multifaceted impact of pentazocine dependence, encompassing direct medical costs, as well as indirect economic consequences such as reduced productivity and impaired social functioning.

The average financial burden associated with pentazocine dependence and its complications among SCD patients in Nsukka, Enugu State, was determined to be NGN 134,002.77/USD 164.42. Notably, the direct cost of pentazocine, medications, hospitalization, and treatment accounted for 87% (NGN 116,587.71/USD 143.1) of the total cost, surpassing the 13% (NGN 17,415.06/USD 21.37) contributed by indirect costs due to the dependence (refer to Table 7). These findings are consistent with a household study conducted in Yenagoa, where patients allocated more resources to direct medication costs than indirect components [37]. However, to the best of our knowledge, no previous studies have delved into the economic burden of pentazocine dependence in Nigeria, highlighting the novelty and significance of this research.

In-depth analysis of the direct medical costs revealed that pentazocine purchases accounted for a substantial portion (25.3%) of the total direct medical expenses, totaling NGN 117,947.5 (USD 144.72). Patients incurred an average cost of NGN 2,144.5 (USD 2.63) per pentazocine purchase, underlining the significant financial commitment required to sustain the dependence. Furthermore, laboratory services cost an average of NGN 8,200 (USD 10.1) per patient, while administration costs for pentazocine constituted NGN 17,999.5 (USD 22.1). The study also uncovered significant initial registration expenses, with an average cost of NGN 2,862.5 (USD 3.51) per patient, highlighting the financial barriers to accessing necessary healthcare services. Additionally, the study emphasized the substantial financial implications linked to the purchase of prescribed drugs and psychotherapy consultations. Patients spent an average of NGN 12,606.5 (USD 1.55) per drug prescription to manage complications arising from pentazocine dependence, demonstrating the financial strain of comprehensive treatment. Psychotherapy consultations, although a minor fraction (0.9%) of the total medical expenditure, amounted to an average cost of NGN 44,000 (USD 53.99), with an additional NGN 30,600 (USD 37.54) for associated psychological therapy, emphasizing the need for holistic interventions to address psychological well-being. Also, the economic burden associated with in-patient admissions was notable, with 12.9% of patients requiring hospitalization due to pentazocine-related complications. The cumulative in-patient admission cost for the study population reached NGN 857,000 (USD 1051.53), underscoring the strain on the healthcare system and the broader society.

The evaluation of direct non-medical costs highlighted the diverse financial burdens faced by patients managing pentazocine dependence. Participants incurred significant expenses related to transportation, both for obtaining pentazocine (NGN 23,749/USD 29.14) and traveling to healthcare facilities for treatment (NGN 66,696.5/ USD 81.83). Additional non-medical costs included expenditure on food during hospital visits or stays, averaging NGN 2,190 (USD 2.69) for 18% of the patients.

Based on a sickle cell prevalence rate of 0.03, the estimated annual financial cost due to pentazocine dependence was projected to be NGN 422,156,564 (USD 517,983.52). These findings suggest potential direct and indirect effects on the economy of the citizens and the state.

Limitations

- The study relied on a small, conveniently selected group of 55 sickle cell disease (SCD) patients from a single Local Government in Enugu State, Nigeria. This may limit the generalizability of the findings to the broader SCD population in the country.
- Data accuracy might be compromised by the cross-sectional nature of the study and the potential for recall bias among participants, affecting the precise recall of resources consumed due to their dependence practices.
- The research did not account for the duration of school absences among student respondents, as the primary emphasis of the study was not on assessing the effects of dependence on education. This may have resulted in a downplaying of the impact of dependence on the educational endeavors of the participants.
- The possibility of the "Hawthorne effect," where participant behavior is influenced by their awareness of being observed, might have affected the accuracy of the responses and behaviors related to their dependence practices.

5. Conclusion

The findings of this study underscore the substantial economic burden associated with pentazocine dependence among sickle cell disease patients in Nsukka, Enugu State. The implications of this burden pose significant challenges not only for the affected patients but also for the healthcare system and the broader economy of Enugu State. There is need for urgent and heightened investments in interventions that effectively monitor the prescription and distribution of

pentazocine. These interventions must emphasize its appropriate use while concurrently addressing the potential risks of dependence and misuse. Moreover, there is a critical and pressing need for comprehensive interventions that holistically address the physical and psychological aspects of pentazocine dependence among sickle cell disease patients. To this end, strategic measures must be formulated to reduce the financial barriers that hinder patients from accessing essential healthcare services. Simultaneously, concerted efforts should be directed towards enhancing the affordability of necessary medications and prioritizing the provision of robust psychological support and rehabilitation services. In parallel, policy initiatives aimed at raising awareness, advocating for early intervention, and preventing the misuse of pentazocine are essential. These measures are crucial in curtailing the burgeoning economic and societal burden posed by pentazocine dependence among sickle cell disease patients. By proactively implementing these strategies, stakeholders can mitigate the adverse effects of the dependence and foster a more sustainable and supportive healthcare environment for the affected individuals and the community at large.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare no conflict of interest.

Statement of ethical approval

The present research work does not contain any studies performed on animals/humans subjects by any of the authors.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

Author contribution statement

- Kingsley C. Eze: Conceived and designed the research, wrote the paper.
- Victor O. Attah: performed the survey, analyzed and interpreted the data, contributed to research logistics.
- Kenneth O. Eze: performed the survey, analyzed and interpreted the data, contributed to research logistics.
- Promise E. Ugwu: analyzed and interpreted the data.

All authors read and approved the final manuscript

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