Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Drug utilization pattern and cost analysis of anticancer drugs among cancer patients attending a tertiary cancer hospital in Nepal: A cross-sectional study

Neha Sigdel
Pokhara Academy of Health Sciences
Anil Bhusal
bhusalanil480@gmail.com

Pokhara Academy of Health Sciences
Krishna Neupane
Pokhara Academy of Health Sciences
Prabha Adhikari
Pokhara Academy of Health Sciences
Radhika Thapa
Manmohan Memorial Institute of Health Sciences
Poonam Pant
Pokhara Academy of Health Sciences

Research Article

Keywords: Anticancer drugs, Drug utilization, WHO prescribing indicators, Cost of illness, Cancer, Nepal

Posted Date: November 5th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11026205/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License

Additional Declarations: No competing interests reported.

Abstract

Cancer imposes a rising and largely out-of-pocket-financed burden in Nepal, yet patient-level data on how anticancer drugs are prescribed and what chemotherapy actually costs patients remain limited. This study described the drug utilization pattern and cost of anticancer drug therapy among cancer patients treated at a tertiary cancer hospital in Nepal.

A descriptive, cross-sectional, record-based study was conducted at Bhaktapur Cancer Hospital, Bhaktapur, Nepal. Medical records of cancer patients aged above 18 years attending the day-care chemotherapy ward were reviewed using a structured proforma. Sociodemographic characteristics, diagnosis, regimen and cycle data, and WHO/INRUD prescribing indicators were recorded, along with the actual cost, maximum retail price, and Nepal Health Insurance Board reimbursement rate for anticancer drug therapy. Data were analyzed descriptively and, given the skewed distribution of cost, on a log-transformed cost variable using Pearson correlation, independent-samples t tests, and multiple linear regression in SPSS version 16.

A total of 151 chemotherapy patients were analyzed (mean age 53.81 ± 12.51 years; 67.5% female). Breast cancer (26.5%) was the most common diagnosis. Patients received a mean of 10.56 ± 2.19 total drugs, of which 1.72 ± 0.67 were anticancer agents; 99.85% of drugs were prescribed generically, and 63.2–67.7% were on the national essential medicines list. Mean actual cost of anticancer therapy per patient was NPR 15,245.28 ± 15,672.33, substantially below the mean maximum retail price (NPR 38,803.22). In bivariate analysis, log-transformed cost was significantly higher among male patients ($p = .038$) and among patients not fully compliant with the essential medicines list ($p = .028$), but no patient, disease, or prescribing variable — including sex — independently predicted log-transformed cost in a multiple regression model that was not statistically significant overall ($R^2 = .113$, $p = .323$).

Anticancer prescribing at this hospital was characterized by near-universal generic use but only partial alignment with the national essential medicines list, and chemotherapy cost varied widely across patients without being reliably explained by the patient or prescribing factors examined. These findings support continued WHO/INRUD-style prescribing surveillance and closer attention to essential-medicines-list adherence and drug pricing in this setting.

Introduction

Cancer is an escalating public health concern in Nepal: GLOBOCAN 2020 estimated 20,508 new cancer cases and 13,629 cancer-related deaths nationally, with an age-standardized incidence rate of 80.9 and mortality rate of 54.8 per 100,000 population[1]. Chemotherapy remains a cornerstone of treatment for most solid and hematologic malignancies, typically combining one or more anticancer agents with adjuvant and supportive drugs across multiple cycles. Because these regimens are complex, costly, and carry a narrow therapeutic index, periodic evaluation of how anticancer drugs are actually prescribed — and what that prescribing costs patients — is an important complement to clinical guideline development.

Consistent with global trends, in which cancer accounted for an estimated 9.6 million deaths in 2019 and the burden continues to concentrate in low- and middle-income countries where health systems are least

equipped to absorb it[2], Nepal's cancer burden is shifting toward the resource-intensive, chronic-management model typical of non-communicable disease care, in which repeated, multi-drug chemotherapy cycles rather than single curative interventions define much of clinical practice.

Chemotherapy regimens for common malignancies increasingly combine multiple cytotoxic, targeted, and supportive agents across several cycles, and this complexity raises the practical importance of monitoring not only clinical outcomes but also how these drugs are actually selected, combined, and paid for at the point of care.

The World Health Organization/International Network for Rational Use of Drugs (WHO/INRUD) core prescribing indicators — average drugs per encounter, percentage prescribed by generic name, and percentage prescribed from an essential medicines list, among others — provide a standardized framework for describing prescribing patterns and flagging potentially irrational drug use[3]. In Nepal, the National List of Essential Medicines (NLEM), most recently revised in 2021, includes a dedicated section on antineoplastic and immunomodulating agents and is the relevant benchmark against which anticancer prescribing can be assessed[4]. Hospital-based studies applying these indicators to oncology settings in Nepal remain few. A recent study at a 110-bed national referral-level cancer hospital found a mean of 8.44 ± 3.27 adverse drug reactions per enrolled patient, underscoring both the intensity of drug exposure in this population and the value of systematic, encounter-level prescribing data[5]; a separate drug utilization study of lung cancer patients at the same hospital reported an average of 9.28 drugs prescribed per encounter[6].

Since their original WHO formulation, these core prescribing indicators have been applied and cross-validated across a wide range of settings and specialties beyond oncology — including public hospitals in eastern Ethiopia[7], primary healthcare centers and tertiary hospitals in Bahawalpur, Pakistan[8], a university referral hospital in southern Ethiopia[9], and a tertiary hospital in southeastern Nigeria [10] — which consistently show that average drugs per encounter, generic-prescribing rates, and essential-medicines-list adherence vary widely by country, facility level, and case mix, underscoring the value of setting- and specialty-specific data rather than relying on indicators derived elsewhere.

Within oncology specifically, WHO/INRUD-based drug utilization evaluations have been conducted at tertiary cancer centers in India, reporting an average of 1.72–2.11 anticancer drugs and 8.77–12.22 total drugs per encounter alongside predominantly platinum- and antimetabolite-based regimens [11–13], and adverse-drug-reaction surveillance studies in Eastern Indian teaching hospitals have documented substantial toxicity burden associated with these same drug classes [14–16], reinforcing that utilization pattern and safety monitoring are complementary lenses on the same underlying prescribing practice. In Nepal, a pharmacovigilance center specifically for chemotherapy-related reactions was established at a national cancer hospital to address this gap[17], and a validated tool for predicting chemotherapy-induced neutropenia risk has since been piloted in the same setting[18], reflecting a broader institutional shift toward more systematic monitoring of anticancer drug use and its consequences.

The financial dimension of cancer treatment in Nepal is similarly under-documented at the prescribing level. Nepal's health financing relies heavily on out-of-pocket payment, and a cross-sectional study at a

tertiary cancer hospital estimated a mean direct cost of cancer treatment of NPR 387,500 per patient, with medical costs accounting for over 80% of that total and the great majority of patients reporting financial hardship as a result[19]. Compounding this burden, an assessment of anticancer medicine pricing across Nepalese hospital pharmacies found considerable brand-level price variation — in some cases exceeding 300% for the same molecule — despite government price regulation of selected products[20]. Together, these findings suggest that the cost actually paid for a course of anticancer therapy may diverge substantially from list or maximum retail prices, and that this divergence is worth quantifying alongside prescribing pattern.

Selection of which cancer medicines a country's essential medicines list should include is itself an active area of international policy attention: the WHO Cancer Medicines Working Group has progressively tightened the evidentiary bar — including a minimum overall-survival-benefit threshold — for adding new cancer medicines to its Model List [21], a shift reflected in 2021 when WHO announced it was prioritizing access to cancer and diabetes treatments in its updated Essential Medicines Lists; yet a survey of oncologists across 82 countries found that even medicines they consider essential are inconsistently available, particularly in low- and lower-middle-income settings[22], and a related analysis found that fewer than half of the cancer medicines recommended by international treatment guidelines are typically reflected in the national essential medicines lists of low- and middle-income countries[23]. Older essential-medicines-programme evaluations reached similar conclusions decades earlier, finding that structured essential-drug programmes improve both availability and rational use where implemented consistently[24], and a widely cited set of policy recommendations for improving medicine use in developing countries specifically highlighted prescribing audits and essential-list adherence monitoring — exactly the kind of patient-level indicator collected in this study — as practical levers for improvement[25]. Nepal's own essential medicines list has followed this international trajectory, with its most recent (sixth) revision retaining a dedicated antineoplastic and immunomodulating-agent section aligned to the WHO Model List framework.

Despite this evidence, few Nepalese studies have jointly examined anticancer drug utilization and the cost of therapy at the level of the individual chemotherapy patient, across a broad mix of cancer diagnoses rather than a single tumor type. This study therefore aimed to describe the sociodemographic and disease profile, drug prescribing pattern, and cost of anticancer drug therapy among cancer patients attending a tertiary cancer hospital in Nepal, and to examine which patient, disease, and prescribing characteristics were associated with that cost.

Methods

Study design and setting

This was a descriptive, cross-sectional study using quantitative methods, conducted at Bhaktapur Cancer Hospital, Dudhpati, Bhaktapur, Nepal — a well-recognized national-level cancer hospital that draws patients from across the country[5]. The study was conducted over approximately two months, from 9 May 2022 to 29 June 2022.

Participants

The study population comprised patients visiting Bhaktapur Cancer Hospital for chemotherapy; the study unit was the individual patient diagnosed with cancer. Patients above 18 years of age were eligible for inclusion; patients unwilling to participate were excluded. The minimum required sample size was estimated using Cochran's formula for an infinite population proportion:

$$n = Z^2 p(1 - p) / d^2$$

where Z is the standard normal deviate corresponding to the desired confidence level (Z = 1.96 for 95% confidence), p is the assumed prevalence of the outcome of interest (p = 9.588%, based on the brand-level price-variation proportion reported for anticancer medicines in Nepalese hospital pharmacies[20], used here in the absence of a study-specific prior estimate of prescribing or cost outcomes), and d is the desired absolute precision (d = 0.05). Substituting these values, $n = (1.96)^2 \times 0.09588 \times (1 - 0.09588) / (0.05)^2 = 3.8416 \times 0.0867 / 0.0025 \approx 134$, giving a calculated minimum target of 134 chemotherapy patients. Anticipating a non-response rate of 15%, a conservative allowance commonly applied in sample-size planning for survey- and record-based health research, this minimum target was adjusted to $n / (1 - 0.15) = 134 / 0.85 \approx 158$ chemotherapy patients. The achieved sample of 151 patients therefore corresponds to a response rate of $151/158 \approx 95.6\%$ relative to this adjusted target.

Data collection

Data were abstracted from patients' medical records and prescriptions using a structured data collection form (proforma) developed for this study, after a pretest on 10% of the anticipated sample to check clarity and completeness. For each patient, the form captured sociodemographic characteristics (age, sex, ethnicity, marital status), diagnosis, chemotherapy cycle number and regimen, the anticancer and supportive drugs prescribed, and the cost of anticancer drug therapy. Printed data collection forms were used in the field, and data were subsequently entered into SPSS version 16 for analysis; all collected forms were reviewed daily for completeness and accuracy.

Measures

Drug prescribing pattern was characterized using WHO/INRUD-adapted prescribing indicators, including the number of anticancer, adjuvant, and supportive drugs prescribed per patient; the route of administration; the percentage of drugs prescribed by generic name; and the percentage of drugs appearing on the Nepal National List of Essential Medicines (NLEM) 2021, evaluated under both a strict and a borderline-inclusive matching criterion[4]. Regimen complexity was classified as monotherapy or combination therapy, and patient-level indicators were recorded for antibiotic co-prescription, use of an additional (non-chemotherapy) injection, and use of a cytoprotective drug. Cost of anticancer drug therapy was recorded per patient as the total actual cost paid (NPR), the total maximum retail price (MRP), and the applicable Nepal Health Insurance Board (HIB) reimbursement rate.

Statistical analysis

Data were analyzed in SPSS version 16. Descriptive statistics (means, standard deviations, minimum/maximum, frequencies, and percentages) summarized demographic, disease, and prescribing variables (N = 151 for all variables, with no missing data on any core variable). Distributional shape was assessed using skewness and kurtosis and formally tested with the Shapiro–Wilk and Kolmogorov–Smirnov tests via the EXAMINE procedure; because Total_Cost was markedly right-skewed and leptokurtic, a natural log transformation (LogCost) was applied and retained as the dependent variable for all inferential analyses of cost.

Bivariate associations between LogCost and continuous predictors (patient age, chemotherapy cycle number, total anticancer and total prescribed drugs per patient, and percentage of drugs generic or NLEM-listed) were examined with Pearson product-moment correlation. Comparisons of mean LogCost across binary prescribing and demographic indicators (sex, antibiotic co-prescription, additional injection use, cytoprotective-drug use, regimen type, all-drugs-generic status, and strict NLEM compliance) were conducted with independent-samples t tests, with Levene's test used to check the equality-of-variances assumption for each comparison. One-way analyses of variance (ANOVA), with Tukey and Games-Howell post-hoc comparisons, were specified to compare LogCost across diagnosis, organ system, broad age band, ethnicity, and chemotherapy cycle-count group.

A standard multiple linear regression was used to examine the joint contribution of patient, disease, and prescribing characteristics — age, sex, cycle number, regimen complexity, total anticancer drugs, total drugs prescribed, antibiotic co-prescription, additional injection use, cytoprotective-drug use, percentage of drugs on the strict NLEM list, and organ-system dummy variables (reference: breast) — to LogCost. Model diagnostics included the overall model F test and R^2/adjusted R^2, tolerance and variance inflation factors (VIF) to assess multicollinearity, the Durbin–Watson statistic to assess residual autocorrelation, and standardized residuals and Cook's distance to identify influential cases; the normal P-P plot and histogram of standardized residuals were inspected to check the normality assumption. A significance threshold of $\alpha = .05$ (two-tailed) was used throughout.

Ethical consideration

Ethical approval

was obtained from the Institutional Review Committee (IRC) of CIST College, Pokhara University (Approval No. IRC/114/078/79), and administrative approval was subsequently obtained from Bhaktapur Cancer Hospital. Because data were abstracted from existing medical records, participants were informed of the study objective and both written and verbal consent were obtained from patients where applicable. Confidentiality of participant information was maintained throughout data collection, analysis, and reporting, and data were used solely for research purposes. Participation was voluntary throughout.

Results

Drug utilization pattern

Sample Characteristics

A total of 151 chemotherapy patients were included in the analysis, with no missing data on any of the core demographic or clinical variables. Patients ranged in age from 19 to 78 years (M = 53.81, SD = 12.51). The majority of the sample was female (67.5%, n = 102), with males comprising 32.5% (n = 49). The most represented age group was 40–59 years (51.0%), followed by ≥ 60 years (34.4%); patients aged 18–39 years were least represented (14.6%). By ethnic/social group, the sample was composed of Janajati (38.4%), Brahmin/Chhetri (35.8%), Newar (22.5%), and a small combined 'Others' category comprising Dalit, Madhesi, and unknown classifications (3.3%). Breast cancer was the most common diagnosis (26.5%), followed by lung cancer (16.6%) and ovarian cancer (10.5%); no other single diagnosis exceeded 7% of the sample, and diagnoses with fewer than five cases were collapsed into an 'Others' category (21.9%). When regrouped by organ system, breast cancer again predominated (26.5%), followed by the gynecological/reproductive system (22.5%), the gastrointestinal system (17.2%), and the respiratory system (16.6%); genitourinary and hematologic diagnoses were combined into a residual 'Others' category (4.6%) owing to small cell sizes. Chemotherapy cycle number ranged from 1 to 14 (M = 3.49, SD = 2.17), with cycle 1 (20.5%) and cycle 3 (20.5%) the most frequently recorded and cycles of 7 or more collapsed into a single category (8.7%). Regimen complexity was classified as combination therapy for 60.3% of patients (n = 91) and monotherapy for 39.7% (n = 60); no patients had regimen type unrecorded. The demographic and clinical characteristics of the study participants are presented in Table 1.

Table 1
Frequency Distribution of Demographic and Disease-Related Variables (N = 151)

Variable / Category	n	%
Sex		
Male	49	32.5
Female	102	67.5
Age Group		
18–39	22	14.6
40–59	77	51.0
≥60	52	34.4
Ethnicity / social group		
Brahmin/Chhetri	54	35.8
Janajati	58	38.4
Newar	34	22.5
Others (Dalit/Madhesi/Unknown)	5	3.3
Cancer diagnosis		
Breast	40	26.5
Cervical	10	6.6
Esophagus	5	3.3
Lung	25	16.6
Nasopharynx	6	4.0
Ovarian	16	10.5
Rectum	5	3.3
Stomach	6	4.0
Supraglottis	5	3.3
Others (< 5 cases each)	33	21.9
Organ system group		
Breast	40	26.5
Gastrointestinal	26	17.2

Note. N = 151 for all variables with no missing data. Percentages are column (valid) percentages.

Variable / Category	n	%
Sex		
Gynecological (Reproductive)	34	22.5
Head & Neck	19	12.6
Respiratory	25	16.6
Others (Genitourinary/Hematologic)	7	4.6
Chemotherapy cycle group		
1	31	20.5
2	23	15.2
3	31	20.5
4	27	17.9
5	14	9.3
6	12	7.9
≥7	13	8.7
Regimen complexity		
Monotherapy	60	39.7
Combination therapy	91	60.3
Note. N = 151 for all variables with no missing data. Percentages are column (valid) percentages.		

Prescribing Indicators

On average, patients received 1.72 anticancer drugs (SD = 0.67, range 1–4), of which 1.60 (SD = 0.68) were administered intravenously and 0.11 (SD = 0.32) orally. Patients additionally received an average of 3.70 injectable adjuvant drugs (SD = 1.15, range 0–7) and 5.15 oral supportive drugs (SD = 1.45, range 0–8), yielding a mean of 10.56 total drugs prescribed per patient (SD = 2.19, range 3–16) (Table 2). Prescribing quality indicators showed a very high rate of generic prescribing, with an average of 99.85% of drugs per patient prescribed by generic name (SD = 1.08%), and 98.0% of patients (n = 148) having all drugs prescribed generically. Adherence to the Nepal National List of Essential Medicines (NLEM) 2021 was more variable: on a strict matching criterion, an average of 63.17% of drugs per patient appeared on the NLEM (SD = 20.28%), and only 3.3% of patients (n = 5) had every drug on the strict NLEM list. When borderline matches were included, the average rose to 67.67% of drugs per patient (SD = 17.56%). Antibiotic co-prescription was rare, occurring in only 2.0% of patients (n = 3), and should be interpreted with caution given the very small cell size. An additional (non-chemotherapy) injection was used in 6.6% of patients (n = 10), and a cytoprotective drug was co-prescribed in 27.2% of patients (n = 41) (Table 3). The WHO/INRUD-adapted core prescribing indicators for the sample are summarized in Table 4.

Table 2
Descriptive Statistics for Continuous Prescribing Indicators (N = 151)

Variable	Min	Max	M	SD
Total anticancer drugs / patient	1.00	4.00	1.72	0.67
IV anticancer drugs / patient	1.00	4.00	1.60	0.68
Oral anticancer drugs / patient	0.00	1.00	0.11	0.32
Adjuvant (injectable) drugs / patient	0.00	7.00	3.70	1.15
Oral supportive drugs / patient	0.00	8.00	5.15	1.45
Total drugs / patient (all categories)	3.00	16.00	10.56	2.19
% drugs generic / patient	91.67	100.00	99.85	1.08
% drugs on NLEM 2021, strict	25.00	100.00	63.17	20.28
% drugs on NLEM 2021, incl. borderline	33.33	100.00	67.67	17.56

Table 3
Frequency of Patient-Level Drug-Related Prescribing Indicators (N = 151)

Indicator	No / 0 (n)	%	Yes / 1 (n)	%
Antibiotic co-prescribed	148	98.0	3	2.0
Additional injection used	141	93.4	10	6.6
Cytoprotective drug used	110	72.8	41	27.2
All drugs generic (patient-level)	3	2.0	148	98.0
All drugs on NLEM 2021, strict (patient-level)	146	96.7	5	3.3

Note. “All drugs generic” and “All drugs on NLEM, strict” are patient-level composite indicators, coded 1 only when every drug for that patient met the respective criterion.

Table 4
WHO/INRUD-Adapted Core Prescribing Indicators (N = 151)

Indicator	Value
Average number of drugs prescribed per patient (all categories)	10.56 ± 2.19
Average number of anticancer drugs per patient	1.72 ± 0.67
Patients prescribed combination anticancer therapy	60.3% (91/151)
Patients prescribed anticancer monotherapy	39.7% (60/151)
Patients with an antibiotic co-prescribed	2.0% (3/151)
Patients with an additional injection prescribed	6.6% (10/151)
Patients with a cytoprotective drug prescribed	27.2% (41/151)

Note. Values are M ± SD or % (n/N). Indicators are adapted from, but not identical to, the standard WHO/INRUD core prescribing indicator set; anticancer-specific and regimen-complexity measures replace the standard % generic and % essential-medicines-list indicators, which are reported separately in Table 3.

Cost Analysis of Anticancer Therapy

Cost Variables

The average cost of anticancer therapy was NPR 15,245.28 per patient, ranging from NPR 1,665.60 to NPR 101,251.96. The average maximum retail price was NPR 38,803.22, and the average Nepal Health Insurance Board reimbursement rate was NPR 25,852.36. Cost varied widely across patients, with a small number of high-cost patients raising the average well above the typical (median) cost of NPR 11,196.00 (Table 5). A log-transformed cost variable (LogCost) was used for the comparisons and regression analysis below, since it more closely approximated a normal distribution than the raw cost values (Additional File 1, Table S3).

Table 5
Cost of Anticancer Drug Therapy per Patient (NPR)

Cost measure	Mean ± SD	95% CI	Median	Min–Max
Total actual cost	15,245.28 ± 15,672.33	12,725.22, 17,765.35	11,196.00	1,665.60–101,251.96
Total maximum retail price (MRP)	38,803.22 ± 29,157.04	34,114.85, 43,491.59	32,556.48	5,426.08–200,066.93
Total cost, Health Insurance Board rate	25,852.36 ± 21,778.96	22,350.36, 29,354.36	21,156.18	3,526.03–145,886.82

Note. Mean, SD, median, minimum, and maximum are from the Section 3 DESCRIPTIVES output. The 95% CI for Total_Cost is taken directly from the EXAMINE procedure; the 95% CIs for MRP and the HIB rate were calculated as Mean ± $t_{0.975,150}$ × (SD/√N), using the critical value (t ≈ 1.976, df = 150) implied by the EXAMINE-derived CI for Total_Cost. IQR was not printed in the available output and is therefore omitted rather than estimated.

Bivariate Associations with Cost

Cost was not related to patient age, chemotherapy cycle number, the number of drugs prescribed, or the percentage of drugs that were generic or on the essential medicines list. However, cost was higher among male patients than female patients and among patients whose drugs were not fully on the essential medicines list; it did not differ by antibiotic co-prescription, additional injection use, cytoprotective drug use, regimen type, or generic prescribing status (Additional File 1, Tables S1–S2).

Multiple Linear Regression Predicting Log-Transformed Cost

A multiple linear regression examined the combined contribution of patient age, sex, chemotherapy cycle number, regimen complexity, total anticancer drugs per patient, total drugs prescribed per patient, antibiotic co-prescription, additional injection use, cytoprotective drug use, percentage of drugs on the strict NLEM list, and organ system to cost. Together, these variables accounted for about 11% of the variation in cost (Table 6). None of the individual variables was independently associated with cost (Table 6).

Table 6
Summary of Multiple Regression Coefficients Predicting LogCost (N = 151)

Predictor	β	t	p	95% CI
(Constant)	—	13.25	< .001	[7.591, 10.257]
Patient age	.107	1.15	.254	[-0.004, 0.016]
Sex (Female = 1)	− .068	-0.61	.543	[-0.466, 0.246]
Chemotherapy cycle number	.076	0.89	.375	[-0.033, 0.085]
Regimen: Combination = 1	− .065	-0.31	.755	[-0.729, 0.529]
Total anticancer drugs / patient	− .070	-0.31	.755	[-0.574, 0.418]
Total drugs prescribed / patient	.086	0.89	.378	[-0.037, 0.097]
Antibiotic co-prescribed	− .159	-1.50	.135	[-1.981, 0.269]
Additional injection used	− .124	-1.43	.155	[-0.889, 0.143]
Cytoprotective drug used	.066	0.64	.521	[-0.229, 0.451]
% drugs on NLEM, strict	− .054	-0.60	.553	[-0.008, 0.004]
Organ system: Gastrointestinal	.029	0.24	.812	[-0.425, 0.541]
Organ system: Gynecological	− .036	-0.30	.768	[-0.491, 0.363]
Organ system: Head & Neck	.026	0.19	.849	[-0.548, 0.666]
Organ system: Respiratory	.091	0.72	.472	[-0.320, 0.688]
Organ system: Others (Genitourinary/Hematologic)	.093	0.80	.425	[-0.432, 1.020]

Note. Reference categories: Sex = Male; Regimen = Monotherapy; Organ system = Breast. Dependent variable: LogCost. Overall model: R^2 =.113, adjusted R^2 =.014, $F(15,135) = 1.15$, $p = .323$. VIF = variance inflation factor. 95% CI for B calculated as $B \pm t_{0{\cdot}975,135} \times SE\ B$ ($t_{0{\cdot}975,135} = 1.978$).

Discussion

Among 151 chemotherapy patients at this tertiary cancer hospital, prescribing was characterized by a modest number of anticancer agents per patient (mean 1.72), a substantially larger burden of adjuvant and supportive drugs, near-universal generic prescribing (99.85%), and only partial adherence to the national essential medicines list (63–68%). Mean actual chemotherapy cost per patient (NPR 15,245) was well below mean maximum retail price (NPR 38,803), and cost was highly right-skewed. In bivariate analysis, LogCost was higher among male patients and among patients not fully NLEM-compliant, but no patient, disease, or prescribing variable — including sex — independently predicted LogCost in an overall regression model that did not reach statistical significance.

The demographic and diagnostic profile observed here differs from other Nepalese anticancer drug utilization studies largely as a function of case mix. Our sample was older on average and markedly female-predominant (67.5%), consistent with the predominance of breast and gynecological malignancies (49.0% combined); by contrast, a lung-cancer-focused drug utilization study at the same hospital reported a younger, male-predominant sample (mean age 58.21 ± 13.22 years, 57% male)[6], and an adverse-drug-reaction study across a broader Nepalese oncology sample reported a lower mean age (49.93 ± 14.27 years)[5]. This suggests that patient- and cost-related findings in anticancer drug utilization studies in Nepal may be strongly shaped by the diagnostic mix of the sampled hospital or ward, and comparisons across studies should account for this.

The prescribing volume observed here (10.56 total drugs and 1.72 anticancer drugs per patient) sits within the range reported by other hospital-based anticancer drug utilization studies in South Asia, which have found 8.77–9.28 total drugs per encounter at other Nepalese and Indian centers [6, 12]and up to 12.22 total drugs with 1.73 anticancer drugs per encounter in an Indian government hospital treating metastatic disease[12], as well as 1.72–2.11 anticancer drugs per encounter in tertiary Indian oncology settings [26]. Beyond prescribing volume itself, drug wastage has been identified as a related cost driver in comparable settings, with one Indian tertiary-hospital study quantifying substantial financial loss from chemotherapy drug wastage in paediatric cancer care[27]. This convergence across independently conducted studies, despite differing case mixes and health systems, suggests that a total prescribing burden of roughly 9–13 drugs per chemotherapy encounter — combining cytotoxic agents with antiemetics, gastroprotective drugs, and other supportive therapy — may be a broadly representative feature of real-world combination chemotherapy in South Asian tertiary care, rather than an artifact specific to this hospital.

By contrast, the WHO/INRUD literature outside oncology — spanning general outpatient and primary-care settings in Ethiopia, Pakistan, and Nigeria — typically reports considerably lower average drugs per encounter (1.75–3.4) alongside more variable antibiotic and injection use [7–9]. The higher drug burden in the present sample is therefore best interpreted as a feature of oncology prescribing specifically, where antiemetic, gastroprotective, and other supportive medications are added systematically alongside the anticancer regimen itself, rather than evidence of generally excessive prescribing; this is consistent with adverse-drug-reaction surveillance data from Eastern Indian cancer centers showing that supportive medications are integral to managing the substantial toxicity burden of cytotoxic chemotherapy[15, 16].

Generic prescribing in this sample was essentially complete (99.85% of drugs, 98.0% of patients), a favorable prescribing-quality indicator consistent with WHO/INRUD expectations for rational drug use[3]. Adherence to the NLEM 2021 was more variable, with only 3.3% of patients fully compliant under a strict matching criterion. Because the current NLEM explicitly includes a section on antineoplastic and immunomodulating agents [4], this gap may partly reflect the narrower scope of that list relative to the range of regimens required for the diverse cancer types treated at this hospital, rather than irrational prescribing per se; it nonetheless represents an actionable target for future formulary and procurement review.

This pattern is broadly consistent with international observations that essential-medicines-list adherence for cancer medicines lags behind adherence for medicines used to treat other conditions: a survey of oncologists across 82 countries found inconsistent real-world availability even for medicines respondents themselves regarded as essential[22], and a comparative analysis found that national essential medicines lists in many low- and middle-income countries capture well under half of guideline-recommended oncology medicines[23]. The WHO's own selection criteria for cancer medicines have become progressively more stringent over successive Model List revisions[21], which may itself widen, rather than narrow, the gap between what guidelines recommend, what a national list includes, and what a given hospital actually prescribes — precisely the gap this study's NLEM-adherence indicators are intended to surface locally.

The gap between mean actual cost (NPR 15,245) and mean maximum retail price (NPR 38,803) observed here is consistent with documented brand-level price variation in the Nepalese anticancer medicine market, where price differences between brands of the same molecule have been reported to exceed 300%[20], and with the partial buffering role of the Health Insurance Board reimbursement mechanism (mean NPR 25,852 in this sample). These patient-level costs are considerably smaller in magnitude than the whole-course direct cost of cancer treatment reported elsewhere in Nepal (mean NPR 387,500 per patient, of which medical costs comprised over 80%) [19], reflecting the difference between a single chemotherapy encounter and a full multi-modality treatment course; taken together, however, both findings point to substantial and variable out-of-pocket exposure for Nepalese cancer patients.

These patient-level cost findings echo the broader financial-toxicity literature: landmark work defining and measuring financial toxicity in insured cancer patients in high-income settings found that a majority reported meaningful financial burden despite insurance coverage[28–30], and out-of-pocket cost reviews spanning multiple income settings consistently find that medication costs, rather than consultation or diagnostic fees, dominate the direct cost of cancer care[31] — a pattern directly mirrored here, where anticancer drug cost, rather than any other component of care, was the object of measurement. In the largely uninsured, out-of-pocket-dominated Nepalese context, where the Health Insurance Board mechanism observed in this sample offsets only part of the gap between actual and listed prices, the combination of high MRP-to-paid-cost variability[20] and limited catastrophic-expenditure protection[19] plausibly compounds financial toxicity risk beyond what is described in insured, high-income-country cohorts.

This pattern mirrors a much larger international literature on the financial toxicity of cancer care: out-of-pocket costs have been shown to impose a substantial and often catastrophic burden on patients across income settings, from the United States and Canada to Western Europe and Australia[32], with landmark studies coining and operationalizing the term “financial toxicity” to describe how treatment-related costs can rival clinical toxicity as a source of patient distress and even treatment non-adherence[30]. A systematic review and meta-analysis focused specifically on low- and middle-income countries found pooled prevalence estimates of objective financial toxicity ranging from roughly 18% to over 90% depending on cancer type and setting [33], and a Malaysian study of urologic cancer patients similarly found that both objective and subjective financial toxicity were associated with poorer quality of life[34] — findings broadly

consistent with the high mean chemotherapy cost relative to typical household income observed in the Nepalese context[19].

The attenuation of the sex difference in LogCost between the unadjusted (bivariate) and adjusted (regression) analyses, together with the non-significant overall regression model, suggests that the patient- and prescribing-level variables captured in this study do not by themselves explain much of the variation in chemotherapy cost. This is plausible given that anticancer drug pricing in Nepal varies considerably by brand and manufacturer rather than by patient characteristics[20]; regimen- and drug-selection-level cost drivers not captured here (for example, brand choice, originator versus generic formulation, and negotiated institutional pricing) may be more informative predictors of cost than the demographic and prescribing variables examined in this model.

Strengths and limitations of the study

This study jointly characterized anticancer drug utilization and cost at the level of the individual chemotherapy patient across a broad mix of cancer diagnoses, an uncommon combination in the existing Nepal-specific literature, which has more often focused on either a single tumor type or on adverse drug reactions rather than cost. Several limitations should be considered. The study was single-center and cross-sectional, precluding causal inference and limiting generalizability to other Nepalese cancer hospitals. The achieved sample (151 patients over a two-month window) corresponded to a response rate of approximately 95.6% relative to the non-response-adjusted minimum target of 158 patients; however, the planned one-way ANOVAs across diagnosis, organ system, age band, ethnicity, and cycle-count group could not be completed in the current analysis and are being re-run. Several patient-level indicators had very small numbers of positive cases (antibiotic co-prescription, n = 3; strict NLEM compliance, n = 5), and comparisons involving these indicators should be interpreted cautiously. Cost data were restricted to the recorded actual cost, maximum retail price, and Health Insurance Board rate for anticancer drugs and did not capture indirect or non-medical costs (for example, travel, lodging, or lost income), which other Nepalese cost-of-cancer studies suggest can be substantial. Finally, a planned non-parametric comparison of untransformed cost by sex, regimen type, and cytoprotective-drug use was not completed in the current analysis and is a further target for revision.

Consistent with methodological guidance from systematic reviews of cancer cost-of-illness studies more broadly, the cost measures used here (actual cost, MRP, and HIB rate) capture direct medical drug cost only; they do not capture indirect costs such as travel, lost wages, or informal caregiving time, which other financial-toxicity literature identifies as substantial additional contributors to the total economic burden of cancer care.

Study implications

These findings support the continued use of WHO/INRUD-style prescribing indicators as a routine monitoring tool in oncology settings, given their ability to flag both prescribing strengths (near-universal generic use) and gaps (partial essential-medicines-list adherence) that might otherwise go unquantified. They also support institutional and policy attention to anticancer drug pricing and procurement —

particularly the gap between listed and paid prices — as a lever for reducing the financial burden of chemotherapy on patients, independent of any single patient or prescribing characteristic.

More broadly, the combination of near-complete generic prescribing with only partial essential-medicines-list adherence observed here is a pattern also seen internationally as national lists struggle to keep pace with evolving guideline recommendations; periodic realignment of hospital procurement and the national list — informed by structured audits of the kind conducted here — remains one of the most consistently recommended, low-cost levers for improving rational medicine use in resource-limited settings.

Conclusion

In this descriptive cross-sectional study of 151 chemotherapy patients at a tertiary cancer hospital in Nepal, anticancer drug prescribing was characterized by near-universal generic use but only partial adherence to the national essential medicines list, and the cost of anticancer drug therapy varied widely and was not reliably explained by the patient, disease, or prescribing factors examined. Continued patient-level monitoring of prescribing pattern and cost, alongside efforts to align anticancer procurement more closely with the essential medicines list and to address brand-level price variation, may help contain the financial burden of chemotherapy in this setting.

Declarations

Ethics approval and consent to participate:

Ethical approval was obtained from the Institutional Review Committee of CIST College, Pokhara University (Approval No. IRC/114/078/79), with administrative approval from Bhaktapur Cancer Hospital. Written and verbal informed consent were obtained from participants where applicable; participation was voluntary and confidentiality was maintained throughout.

Consent for publication:

Not applicable — no individual patient data, images, or identifying information are presented.

Author Contribution

NS conceived the study, developed the research idea, and contributed to study design and overall project direction. AB was primarily responsible for data analysis, statistical analysis using SPSS, interpretation of the results, and drafting and revising the manuscript, including the Results and Discussion sections. KN and PA contributed to data collection, extraction of information from patient records, and organization and entry of data into Microsoft Excel. RT contributed to the nursing-related components of the study, including relevant data collection, interpretation, and manuscript input. PP supervised the study, provided methodological and academic guidance, and critically reviewed the manuscript. All authors contributed to the study, reviewed and approved the final manuscript, and agreed to be accountable for the work.

Acknowledgments

We would like to express our sincere gratitude to the Masters of Pharmaceutical Sciences Program, CiST College, Pokhara University, for providing the opportunity to complete this study as partial fulfillment of the requirements for the Master degree in Clinical Pharmacy.

We are deeply grateful to our supervisor, Ms. Poonam Pant, co-supervisor, Dr. Prayas Ghimire, Prof. Naveen Shrestha, for their supervision, guidance, valuable support, constructive ideas, and feedback throughout this research.

We would like to thank Prof. Dr. Sudhamsu KC, Dr. Dilip Sharma, and all the staff of the Centre for Liver Disease, Kathmandu, for their approval, guidance, support, and for providing the patient-related information required to complete our thesis.

We are also thankful to all the patients and their visiting parties for their kind and supportive behavior.

Finally, we would like to express our gratitude to everyone who directly or indirectly provided their time, support, and guidance for the successful completion of our thesis

Availability of data and materials:

The dataset analyzed in this study is available from the corresponding author on reasonable request.

Competing interests: No competing interests.

Funding: CIST College, Pokhara University

References

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin [Internet]. 2021;71(3):209–49. Available from: https://acsjournals.onlinelibrary.wiley.com/doi/10.3322/caac.21660
2. Kocarnik JM, Compton K, Dean FE, Fu W, Gaw BL, Harvey JD et al. Cancer Incidence, Mortality, Years of Life Lost, Years Lived With Disability, and Disability-Adjusted Life Years for 29 Cancer Groups From 2010 to 2019. JAMA Oncol [Internet]. 2022;8(3):420. Available from: https://jamanetwork.com/journals/jamaoncology/fullarticle/2787350
3. WHO. How to investigate drug use in health facilities: selected drug use indicators [Internet]. WHO. 2025. Available from: https://www.who.int/publications/i/item/who-dap-93.1
4. DDA G. Government of Nepal, Ministry of Health and Population, Department of Drug Administration. National List of Essential Medicines Nepal. 6th revision. Kathmandu: DDA; 2021. [Internet]. DDA

WEBSITE. 2021. Available from: https://dda.gov.np/content/38/national-list-of-essential-medicines-nepal--sixth/

5. Tamang R, Bharati L, Khatiwada AP, Ozaki A, Shrestha S. Pattern of Adverse Drug Reactions Associated with the Use of Anticancer Drugs in an Oncology-Based Hospital of Nepal. JMA J [Internet]. 2022;5(4):416–26. Available from: https://www.jmaj.jp/detail.php?id=10.31662/jmaj.2021-0015
6. STUTI SHRESTHA, SAH KEDARPD, AJAY KUMAR CHAUDHARY, DIPENDRA DEO THAKUR, RABINDRA MAHARA, SHIV KUMAR SHARMA. DRUG UTILIZATION PATTERN AMONG, THE PATIENTS OF LUNG CANCER IN TERTIARY CARE HOSPITAL OF NEPAL. Innovare J Med Sci [Internet]. 2026;9–11. Available from: https://journals.innovareacademics.in/index.php/ijms/article/view/56015
7. Sisay M, Mengistu G, Molla B, Amare F, Gabriel T. Evaluation of rational drug use based on World Health Organization core drug use indicators in selected public hospitals of eastern Ethiopia: a cross sectional study. BMC Health Serv Res [Internet]. 2017;17(1):161. Available from: http://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-017-2097-3
8. Atif M, Sarwar MR, Azeem M, Naz M, Amir S, Nazir K. Assessment of core drug use indicators using WHO/INRUD methodology at primary healthcare centers in Bahawalpur, Pakistan. BMC Health Serv Res [Internet]. 2016;16(1):684. Available from: http://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-016-1932-2
9. Desalegn AA. Assessment of drug use pattern using WHO prescribing indicators at Hawassa University teaching and referral hospital, south Ethiopia: a cross-sectional study. BMC Health Serv Res [Internet]. 2013;13(1):170. Available from: https://bmchealthservres.biomedcentral.com/articles/10.1186/1472-6963-13-170
10. Ogbonna BO, Enyi-Okafor AS, Okoye MI, Ezigbo AO, Achi JC, Nwambanne TA, et al. Assessment of Drug Use in a Tertiary Hospital inSoutheast Nigeria Based on Who Core Drug UseIndicators. Austin J Nurs Heal Care. 2022;9(2):9–12.
11. Bepari A, Sakre N, Rahman I, Niazi SK, Dervesh AM. The Assessment of Drug Utilization Study of Anticancer Drugs Using WHO Prescribing Indicators in a Government Tertiary Care Hospital of the Hyderabad - Karnataka Region of India. Open Access Maced J Med Sci [Internet]. 2019;7(7):1203–8. Available from: https://spiroski.migration.publicknowledgeproject.org/index.php/mjms/article/view/oamjms.2019.249
12. Vijayalakshmi D, Bendi SR, Usharani M, Swarna Latha K. Assessment of drug utilization pattern in patients undergoing chemotherapy for various types of metastatic cancers in a tertiary care government hospital. Int J Basic Clin Pharmacol [Internet]. 2020;9(9):1331. Available from: https://www.ijbcp.com/index.php/ijbcp/article/view/4211
13. Mugada V, Paruchuri A, Munagala M. Drug Utilization Evaluation of Anticancer Drugs in a Tertiary Care Teaching Hospital: a Descriptive Observational Study. J Appl Pharm Sci [Internet]. 2016;098–101. Available from: http://www.japsonline.com/abstract.php?article_id=2019
14. Wahlang JB, Laishram PD, Brahma DK, Sarkar C, Lahon J, Nongkynrih BS. Adverse drug reactions due to cancer chemotherapy in a tertiary care teaching hospital. Ther Adv Drug Saf [Internet]. 2017;8(2):61–6. Available from: https://journals.sagepub.com/doi/10.1177/2042098616672572

15. Chopra D, Rehan H, Sharma V, Mishra R. Chemotherapy-induced adverse drug reactions in oncology patients: A prospective observational survey. Indian J Med Paediatr Oncol [Internet]. 2016;37(01):42–6. Available from: http://www.thieme-connect.de/DOI/DOI?10.4103/0971-5851.177015
16. Rout A, Panda RK, Mishra V, Parida P, Mohanty S. Pharmacovigilance in cancer chemotherapy in regional cancer center of Eastern India: prospective observational study. Int J Basic Clin Pharmacol [Internet]. 2017;6(8):1910. Available from: http://www.ijbcp.com/index.php/ijbcp/article/view/1878
17. Shrestha S, Shrestha S, Khanal S. Establishment of the first cancer hospital-based pharmacovigilance center in Nepal. Res Soc Adm Pharm [Internet]. 2018;14(11):1088–9. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1551741118306752
18. Sapkota B, Shrestha R, Chapagai S, Shakya DK, Bista P. Validation of Risk of Chemotherapy-Induced Neutropenia: Experience from Oncology Hospital of Nepal. Cancer Manag Res [Internet]. 2020;Volume 12:3751–8. Available from: https://www.dovepress.com/validation-of-risk-of-chemotherapy-induced-neutropenia-experience-from-peer-reviewed-article-CMAR
19. Khatiwoda SR, Dhungana RR, Sapkota VP, Singh S. Estimating the Direct Cost of Cancer in Nepal: A Cross-Sectional Study in a Tertiary Cancer Hospital. Front Public Heal [Internet]. 2019;7. Available from: https://www.frontiersin.org/article/10.3389/fpubh.2019.00160/full
20. Shrestha S, Poudel RS, KC B, Poudel BK, Sapkota B, Sharma S et al. Price variation among different brands of anticancer medicines available in hospital pharmacies of Nepal. J Pharm Policy Pract [Internet]. 2020;13(1):6. Available from: https://joppp.biomedcentral.com/articles/10.1186/s40545-020-0203-0
21. Jenei K, Aziz Z, Booth C, Cappello B, Ceppi F, de Vries EGE et al. Cancer medicines on the WHO Model List of Essential Medicines: processes, challenges, and a way forward. Lancet Glob Heal [Internet]. 2022;10(12):e1860–6. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2214109X2200376X
22. Fundytus A, Sengar M, Lombe D, Hopman W, Jalink M, Gyawali B et al. Access to cancer medicines deemed essential by oncologists in 82 countries: an international, cross-sectional survey. Lancet Oncol [Internet]. 2021;22(10):1367–77. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1470204521004630
23. Bazargani YT, de Boer A, Schellens JHM, Leufkens HGM, Mantel-Teeuwisse AK. Selection of oncology medicines in low- and middle-income countries. Ann Oncol [Internet]. 2014;25(1):270–6. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0923753419359666
24. Hogerzeil H, Sallami A, Walker GA, Fernando G, IMPACT OF AN ESSENTIAL DRUGS, PROGRAMME ON AVAILABILITY AND RATIONAL USE OF DRUGS. Lancet [Internet]. 1989;333(8630):141–2. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0140673689911525
25. Laing R. Ten recommendations to improve use of medicines in developing countries. Health Policy Plan [Internet]. 2001;16(1):13–20. Available from: https://academic.oup.com/heapol/article-lookup/doi/10.1093/heapol/16.1.13
26. Mathew M, Mateti UV, Saj N, Philip ML, Shetty V. Drug utilization evaluation of anticancer drugs in a charitable hospital. Indian J Med Paediatr Oncol [Internet]. 2019;40(01):105–10. Available from:

http://www.thieme-connect.de/DOI/DOI?10.4103/ijmpo.ijmpo_156_18

27. Ghate S, Patil S, Kadhe N, Fulsoundar R, Pawar S. Quantification of Chemotherapy Drug Wastage and Incurred Financial Loss in Paediatric Cancer Care: A Cross-Sectional Study at a Tertiary Care Public Hospital in India. Cureus [Internet]. 2024; Available from: https://www.cureus.com/articles/213900-quantification-of-chemotherapy-drug-wastage-and-incurred-financial-loss-in-paediatric-cancer-care-a-cross-sectional-study-at-a-tertiary-care-public-hospital-in-india
28. Jagsi R, Pottow JAE, Griffith KA, Bradley C, Hamilton AS, Graff J et al. Long-Term Financial Burden of Breast Cancer: Experiences of a Diverse Cohort of Survivors Identified Through Population-Based Registries. J Clin Oncol [Internet]. 2014;32(12):1269–76. Available from: https://ascopubs.org/doi/10.1200/JCO.2013.53.0956
29. Zafar SY, Abernethy AP. Financial toxicity, Part I: a new name for a growing problem. Oncology (Williston Park) [Internet]. 2013;27(2):80–1, 149. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23530397
30. Zafar SY, Peppercorn JM, Schrag D, Taylor DH, Goetzinger AM, Zhong X et al. The Financial Toxicity of Cancer Treatment: A Pilot Study Assessing Out-of-Pocket Expenses and the Insured Cancer Patient's Experience. Oncologist [Internet]. 2013;18(4):381–90. Available from: https://academic.oup.com/oncolo/article/18/4/381/6398748
31. Iragorri N, de Oliveira C, Fitzgerald N, Essue B. The Out-of-Pocket Cost Burden of Cancer Care—A Systematic Literature Review. Curr Oncol [Internet]. 2021;28(2):1216–48. Available from: https://www.mdpi.com/1718-7729/28/2/117
32. Bygrave A, Whittaker K, Paul C, Fradgley EA, Varlow M, Aranda S. Australian Experiences of Out-of-Pocket Costs and Financial Burden Following a Cancer Diagnosis: A Systematic Review. Int J Environ Res Public Health [Internet]. 2021;18(5):2422. Available from: https://www.mdpi.com/1660-4601/18/5/2422
33. Donkor A, Atuwo-Ampoh V, Della, Yakanu F, Torgbenu E, Ameyaw EK, Kitson-Mills D et al. Financial toxicity of cancer care in low- and middle-income countries: a systematic review and meta-analysis. Support Care Cancer [Internet]. 2022;30(9):7159–90. Available from: https://link.springer.com/10.1007/s00520-022-07044-z
34. Ting CY, Teh GC, Yu KL, Alias H, Tan HM, Wong LP. Financial toxicity and its associations with health-related quality of life among urologic cancer patients in an upper middle-income country. Support Care Cancer [Internet]. 2020;28(4):1703–15. Available from: http://link.springer.com/10.1007/s00520-019-04975-y

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- S1Pearsoncorrelations.docx
- S2Table.Independentsamplesttests.docx
- S3Table.Normalitytesting.docx

- finaldata.xlsx