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Anatomical and Chemical Characteristics of *Cannabis sativa* L. and Cannabis-Related Health Outcomes Among Adult Males in the Gaza Strip: An Integrated Botanical, Chemical, and Cross-Sectional Study

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الخصائص التشريحية والكيميائية لنبات القنب (*Cannabis sativa L.*) والنتائج الصحية المرتبطة بالقنب بين الذكور البالغين في قطاع غزة: دراسة نباتية وكيميائية ومقطعية متكاملة

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Abstract:

Cannabis sativa L. is a morphologically and chemically diverse species with considerable pharmacological and toxicological relevance. This study integrated botanical observation, cannabinoid profiling, and a cross-sectional assessment of cannabis-related health outcomes among adult males in the Gaza Strip. Cultivated plants were followed through vegetative and reproductive development and evaluated for leaf morphology, phyllotaxy, stem characteristics, floral features, odor, and visible resin accumulation. Female inflorescences were analyzed by HPLC-DAD, while the human component included a convenience sample of 59 displaced males aged ≥18 years from three major governorates in the Gaza Strip who completed a self-administered questionnaire. Cannabis-use frequency and self-reported psychological and cognitive outcomes were analyzed using descriptive statistics and the chi-square test, with statistical significance set at $p < 0.05$. Botanical observations showed palmately compound serrated leaves, a shift from opposite to alternate phyllotaxy, erect ridged stems, sex-differentiated flowers, and visible resin concentrated around reproductive tissues. Chemical analysis showed THCA as the predominant cannabinoid (20.3 mg/g), followed by Δ9-THC (1.2 mg/g), CBDA (0.7 mg/g), CBG (0.5 mg/g), CBD (0.3 mg/g), and CBN (0.2 mg/g). Among participants, 79.7% lived in tents. Anxiety symptoms ($p = 0.006$) and psychotic-like symptoms ($p = 0.017$) were significantly associated with cannabis-use frequency. The findings provide integrated botanical, chemical, and preliminary public-health evidence from the Gaza Strip; however, the cross-sectional design and self-reported outcomes preclude causal interpretation.

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Keywords: *Cannabis sativa*; cannabinoids; HPLC-DAD; THCA; THC; adult males; Gaza Strip; cannabis use; health outcomes; cross-sectional study.

الملخص

يُعدّ نبات القنب (*Cannabis sativa L.*) نوعاً نباتياً متنوعاً من الناحية الشكلية والكيميائية، وله أهمية فارماكولوجية (دوائية) وتكسيكولوجية (سمّية) معتبرة .دمجت هذه الدراسة بين الملاحظة النباتية، وتحليل قطاع القنب (تحديد نسب القنب)، وتقييم مقطعي للنتائج الصحية المرتبطة بتعاطي القنب بين الذكور البالغين في قطاع غزة .تتبعت الدراسة النباتات المزروعة طوال مراحل النمو الخضري والتكاثري، وتم تقييمها من حيث شكل الأوراق، والترتيب الورقي (التفصُّص)، وخصائص الساق، والسمات الزهرية، والرائحة، وتراكم الراتنج المرئي .تم تحليل النورات الأنثوية باستخدام تقنية الفصل اللوني السائل عالي الأداء المزود بمحدد صمامات الثنائي(HPLC-DAD) ، بينما شمل الجزء البشري عينة قصدية مكونة من 59 ذكراً نازحاً تبلغ أعمارهم 18 عاماً فأكثر من ثلاث محافظات رئيسية في قطاع غزة، حيث أتمّوا استبيانًا ذاتي الإجابة .تم تحليل تكرار تعاطي القنب والنتائج النفسية والمعرفية المُبلَّغ عنها ذاتياً باستخدام الإحصاء الوصفي واختبار كاي تربيع(Chi-square) ، مع تحديد مستوى الدلالة الإحصائية عند قيمة $p < 0.05$. أظهرت الملاحظات النباتية أوراقاً راحية مركبة ومسننة، وتحولاً في الترتيب الورقي من التقابل إلى التبادل، وسيخاناً منتصبة ومضلعة، وزهوراً متميزة الجنس، وراتنجاً مرظياً (مرئياً) متمركزاً حول الأنسجة التكاثرية .وأظهر التحليل الكيميائي أن حمض رباعي هيدروكانابينول (THCA) هو القنب السائد (20 3.ملغ/غ)، يليه دلتا-9-تتراهيدروكانابينول (Δ^9-THC) بمعدل (1 2.ملغ/غ)، ثم حمض الكانابيديول (CBDA)بمعدل (0 7.ملغ/غ)، والكانابيجيرول (CBG) بمعدل (0 5.ملغ/غ)، والكانابيديول (CBD) بمعدل (0 3.ملغ/غ)، وأخيراً الكانابينول (CBN) بمعدل (0 2.ملغ/غ .(ومن بين المشاركين، عاش 79 7%.منهم في خيام .وُجد أن أعراض القلق ($p = 0.006$) والأعراض شبيهة الذهان ($p = 0.017$) ترتبط ارتباطاً وثيقاً بتكرار تعاطي القنب .توفر هذه النتائج أدلة نباتية وكيميائية وأولية للصحة العامة متكاملة من قطاع غزة؛ ومع ذلك، فإن التصميم المقطعي للدرّاسة والنتائج المُبلَّغ عنها ذاتياً تحول دون التفسير السببي.

الكلمات المفتاحية: القنب (*Cannabis sativa*)؛ المواد القنبية (القنبيات)؛ تقنية HPLC-DAD؛ حمض THCA؛ مادة THC؛ الذكور البالغون؛ قطاع غزة؛ تعاطي القنب؛ النتائج الصحية؛ دراسة مقطعية.

1. Introduction

Cannabis sativa L. is an annual herbaceous species belonging to the family Cannabaceae and has been cultivated for centuries for fiber, seed, food, medicinal preparations, and psychoactive use. Considerable variation exists among cannabis plants in growth pattern, reproductive characteristics, and phytochemical composition. These differences are influenced by genotype, plant sex, developmental stage, environmental conditions, and post-harvest handling (Andre et al., 2016; Bonini et al., 2018; Fordjour et al., 2023; Simiyu et al., 2022).

A distinctive feature of *Cannabis sativa* is the close relationship between plant anatomy and secondary metabolite production. Glandular trichomes are particularly abundant on female inflorescences and surrounding bracts and represent major sites for the biosynthesis, secretion, and storage of cannabinoids and terpenes (Fordjour et al., 2023; Tanney et al., 2021; Xie et al., 2023). This anatomical specialization helps explain why reproductive tissues are generally richer in cannabinoid-containing resin than most vegetative tissues (Andre et al., 2016; Fordjour et al., 2023).

The phytochemical composition of cannabis is complex. Hundreds of compounds have been identified, including phytocannabinoids, terpenes, flavonoids, phenolic compounds, sterols, fatty acids, and other secondary metabolites (Andre et al., 2016; Fordjour et al., 2023; Pellati et al., 2018; Radwan et al., 2021). Among the most widely studied cannabinoids are delta-9-

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tetrahydrocannabinol (Δ9-THC), cannabidiol (CBD), cannabigerol (CBG), cannabichromene (CBC), cannabinol (CBN), and their acidic precursor forms. In fresh or minimally processed plant material, acidic cannabinoids such as tetrahydrocannabinolic acid (THCA) and cannabidiolic acid (CBDA) may predominate, whereas heat, drying, storage, and aging can alter the balance between acidic and neutral cannabinoids through decarboxylation and degradation processes (Fordjour et al., 2023; Pellati et al., 2018; Radwan et al., 2021).

The biological and health effects associated with cannabis use depend on several factors, including cannabinoid composition, dose, frequency and duration of exposure, age at initiation, route of administration, co-use of other psychoactive substances, and individual susceptibility. Δ9-THC is the principal intoxicating cannabinoid and has been associated with effects on attention, memory, perception, mood, and psychomotor performance, whereas CBD has a different pharmacological profile and does not produce the characteristic intoxication associated with THC (Fordjour et al., 2023; Radwan et al., 2021).

Mental-health outcomes have received particular attention in cannabis research. Systematic reviews and meta-analyses have reported a dose–response relationship between the frequency of cannabis use and psychosis-related outcomes. Robinson et al. (2023) found that risk estimates increased with weekly or more frequent cannabis use and were higher among daily users. Earlier meta-analytic evidence similarly showed a greater risk of psychosis-related outcomes among heavier cannabis users compared with non-users (Marconi et al., 2016). These associations may also be influenced by age at first use, frequency of exposure, trauma history, co-use of other substances, and individual vulnerability (Kiburi et al., 2021).

Evidence from Palestine remains limited. In a cross-sectional study conducted among Palestinian males in the northern West Bank, Damiri et al. (2024) reported that 7.3% of urine samples tested positive for THC and identified significant associations between THC positivity and the use of alcohol, benzodiazepines, and methamphetamines. The authors also highlighted that substance use in Palestine occurs within a complex sociocultural context influenced by economic hardship, poor living conditions, conflict-related stress, and other social and political factors. These findings provide important local context; however, they cannot be directly generalized to the Gaza Strip because of differences in population characteristics, patterns of displacement, living conditions, and access to health and social services.

The Gaza Strip represents a complex setting in which cannabis-related health outcomes may be influenced by multiple overlapping factors. Displacement, psychological stress, disrupted education and employment, housing instability, and limited access to health services may independently affect anxiety, sleep, mood, cognition, and other outcomes that may also be reported among cannabis users. Accordingly, associations observed in a cross-sectional study should be interpreted cautiously and should not be considered evidence that cannabis exposure alone caused the reported symptoms.

The present study was designed to integrate three complementary dimensions that are often examined separately: the botanical characteristics of *Cannabis sativa* L., its cannabinoid profile, and self-reported health outcomes among adult male cannabis users in the Gaza Strip. The study therefore aimed to describe the external anatomical characteristics of cultivated *Cannabis sativa* L., characterize the cannabinoid profile of female inflorescences, and examine cannabis-related health outcomes among adult males in the Gaza Strip using a cross-sectional approach.

Materials and Methods

2.1 Study Design

An integrated study design was used, combining botanical observation, chemical analysis, and a cross-sectional human survey. The botanical component involved direct cultivation follow-

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up and morphological assessment of *Cannabis sativa* L., while the chemical component included HPLC-DAD profiling of selected cannabinoids in female inflorescences.

For the human component, convenience sampling was used to recruit males aged ≥18 years from three major governorates in the Gaza Strip. The cross-sectional study was conducted in 2026 and focused on displaced men residing either in tents or in houses.

The botanical, chemical, and human components were analyzed as complementary but distinct parts of the study. The cannabinoid profile of the cultivated plant material was not assumed to represent the cannabis products used by survey participants.

2.2 Botanical Observation and Morphological Assessment

Cultivated *Cannabis sativa* L. plants were followed from the vegetative stage through reproductive development under local growing conditions. Morphological assessment focused on externally observable plant characteristics, including leaf architecture, leaflet number and shape, leaf margins, phyllotaxy, stem morphology, branching pattern, floral characteristics, odor, and visible resin accumulation.

Observations were recorded descriptively and compared with established botanical descriptions of *Cannabis sativa* (Andre et al., 2016; Bonini et al., 2018; Fordjour et al., 2023; Simiyu et al., 2022).

Cultivar identity, exact cultivation dates, and detailed controlled-environment parameters were not available and were therefore not included among the reported study variables.

2.3 Anatomical Assessment

The anatomical assessment focused on macroscopic plant characteristics and the distribution of visible resin-associated structures, particularly around female reproductive tissues. Particular attention was given to glandular trichome-rich regions because these structures are recognized as major sites for the biosynthesis, secretion, and storage of cannabinoids and terpenes (Fordjour et al., 2023; Tanney et al., 2021; Xie et al., 2023).

The assessment was limited to externally observable anatomical features. No histological sectioning, microscopic imaging, or quantitative measurement of trichome density was performed; therefore, no microscopic measurements are reported as primary findings.

2.4 Chemical Analysis

Female inflorescences of *Cannabis sativa* L. were analyzed for selected cannabinoids using high-performance liquid chromatography with diode-array detection (HPLC-DAD). Chromatographic separation was performed on a C18 reversed-phase column using a water/acetonitrile mobile phase containing 0.1% formic acid, with detection carried out at 228 nm.

The analyzed cannabinoids included delta-9-tetrahydrocannabinol (Δ9-THC), tetrahydrocannabinolic acid (THCA), cannabidiol (CBD), cannabidiolic acid (CBDA), cannabigerol (CBG), and cannabinol (CBN). Compounds were identified by comparing retention times and ultraviolet absorption spectra with certified reference standards. Quantification was performed using external calibration curves, and cannabinoid concentrations were expressed as mg/g of plant material.

2.5 Questionnaire Component

The cross-sectional human component included 59 male participants aged ≥18 years who were recruited through convenience sampling from three major governorates in the Gaza Strip. Participants were personally invited to take part in the study and completed a self-administered questionnaire addressing cannabis use, sociodemographic characteristics, and self-reported health outcomes.

Because cannabis use may be associated with social stigma and concerns about potential legal consequences, recruitment and data collection were conducted using neutral and non-stigmatizing language. Participants were informed that participation was voluntary and that they could decline or withdraw without any negative consequences.

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To protect privacy and confidentiality, participants were identified using coded numbers rather than names, and questionnaire data were handled without direct personal identifiers.

2.6 Variables and Outcome Definitions

Sociodemographic variables included age, type of residence, educational level, marital status, and employment status. Participants were categorized into three age groups: 18–25 years, 26–34 years, and ≥35 years. Type of residence was classified as tent or house. Educational level was categorized as illiterate, basic or secondary education, or university education or higher. Marital status was categorized as single or married, and employment status as employed or unemployed.

The main exposure variable in the human component was cannabis-use frequency, which was classified as low-frequency, weekly, or daily use.

Self-reported health outcomes included anxiety symptoms, sleep disturbance, memory complaints, reduced concentration, mood changes, and psychotic-like symptoms. These outcomes were based on questionnaire responses and were not derived from clinical or psychiatric diagnostic assessment. Accordingly, psychotic-like symptoms refer to self-reported experiences and should not be interpreted as a confirmed diagnosis of psychosis.

2.7 Statistical Analysis

Questionnaire data were summarized using frequencies and percentages. The chi-square test was used to examine associations between categorical variables, including sociodemographic characteristics, cannabis-use frequency, and self-reported health outcomes.

Statistical significance was set at $p < 0.05$. All analyses were performed using IBM SPSS Statistics for Mac, version 21 (IBM Corp., Armonk, NY, USA).

2.8 Ethical Considerations

The study was approved by the Emergency Committee in the Gaza Strip (Approval No. Med Sep. 2026/35; 28 September 2026). Informed consent was obtained from all participants before enrollment in the study.

Participation was voluntary, and participants were informed of their right to decline participation or withdraw at any time without any adverse consequences. Neutral and non-stigmatizing language was used during recruitment and data collection. To protect privacy and confidentiality, participants were assigned coded identification numbers rather than names, and no direct personal identifiers were used in the analysis.

3. Results

3.1 External Morphology and Growth Characteristics

Direct observation of cultivated *Cannabis sativa* L. showed palmately compound leaves, commonly consisting of five, seven, or nine leaflets. The leaflets were narrow and lanceolate, with clearly serrated margins. The upper leaf surface appeared darker green than the lower surface.

Leaf arrangement was predominantly opposite on the lower portions of the plant and became increasingly alternate toward the upper parts. The stems were erect, coarse, and longitudinally ridged, with evident branching.

Plant height ranged from approximately 1 m to several meters depending on plant type and growing conditions. Flowers were small and sexually differentiated. Male flowers occurred in relatively loose, branched clusters, whereas female flowers were arranged in denser groups around branch tips and leaf axils.

A strong herbal-resinous odor was observed, particularly after handling the leaves or flowers. A sticky, shiny resinous layer was visible on the flowers and adjacent leaves.

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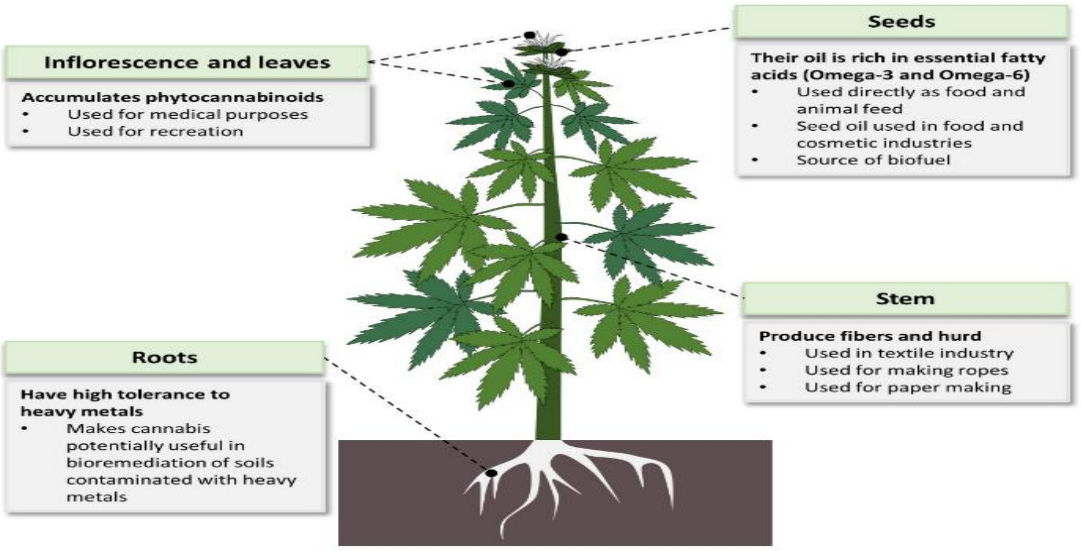


Figure 1. Major organs of *Cannabis sativa* L. and their commonly reported uses. Adapted from Simiyu et al. (2022).



Figure 2. *Cannabis sativa* L. plant photographed during the cultivation follow-up conducted in the present study.



Figure 3. Representative inflorescence and seeds of *Cannabis sativa* L. Adapted from Simiyu et al. (2022).

Table 1. Principal morphological characteristics observed in cultivated *Cannabis sativa* L. during plant follow-up

Character	Recorded observation
Leaf type	Palmately compound
Number of leaflets	Commonly 5, 7, or 9
Leaflet shape	Narrow, lanceolate
Leaf margin	Clearly serrated
Leaf color	Darker green above and lighter below
Leaf arrangement	Opposite on lower portions, increasingly alternate upward
Stem	Erect, coarse, longitudinally ridged; branching evident
Flowers	Small; male flowers in looser branched clusters, female flowers in denser axillary/terminal groups
Odor	Strong herbal-resinous odor, more evident after handling
Visible resin	Sticky, shiny resinous layer on flowers and nearby leaves

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3.2 Anatomical Relevance of Resin-Producing Structures

Visible resin accumulation was concentrated mainly around female reproductive tissues and adjacent leaves. This distribution corresponded to regions known to contain high densities of glandular trichomes, which are specialized epidermal structures involved in the biosynthesis, secretion, and storage of cannabinoids and terpenes (Fordjour et al., 2023; Tanney et al., 2021; Xie et al., 2023).

In the present study, the assessment was limited to macroscopic observation of resin-rich regions. No quantitative measurement of trichome density or microscopic characterization of glandular structures was performed.

3.3 Chemical Profile of Female Inflorescences

HPLC-DAD analysis identified six cannabinoids in the female inflorescences of *Cannabis sativa* L. THCA showed the highest concentration at 20.3 mg/g, followed by Δ9-THC at 1.2 mg/g, CBDA at 0.7 mg/g, CBG at 0.5 mg/g, CBD at 0.3 mg/g, and CBN at 0.2 mg/g.

THCA was therefore the predominant cannabinoid in the analyzed profile. The concentrations of all quantified cannabinoids are presented in Table 2.

Table 2. Cannabinoid concentrations in female inflorescences of *Cannabis sativa* L. determined by HPLC-DAD

Compound	Plant material	Concentration (mg/g)	Analytical platform
Δ9-THC	Female inflorescence	1.2	HPLC-DAD
THCA	Female inflorescence	20.3	HPLC-DAD
CBD	Female inflorescence	0.3	HPLC-DAD
CBDA	Female inflorescence	0.7	HPLC-DAD
CBG	Female inflorescence	0.5	HPLC-DAD
CBN	Female inflorescence	0.2	HPLC-DAD

3.4 Characteristics of Questionnaire Participants

The study included 59 adult male participants aged ≥18 years. The largest age group was 26–34 years (47.4%), followed by participants aged ≥35 years (39.0%) and those aged 18–25 years (13.6%). Most participants were married (67.8%), while 32.2% were single.

Regarding residence, 79.7% of participants were living in tents and 20.3% in houses. In terms of employment status, 59.3% were employed and 40.7% were unemployed. Educational attainment varied across the sample, with 45.8% classified as illiterate, 13.6% having basic or secondary education, and 40.7% having a university degree or higher. The sociodemographic characteristics of the participants are summarized in Table 3.

Table 3. Sociodemographic characteristics of adult male participants in the Gaza Strip, 2026 (N = 59)

Characteristic	N (59)	%
Age 18–25 years	8	13.6
Age 26–34 years	28	47.4
Age ≥35 years	23	39.0
Single	19	32.2
Married	40	67.8
Illiterate	27	45.8
Basic/secondary education	8	13.6
Bachelor degree or higher	24	40.7

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House	12	20.3
Tent	47	79.7
Employed	35	59.3
Unemployed	24	40.7

3.5 Self-Reported Health Outcomes by Cannabis-Use Frequency

Self-reported psychological and cognitive outcomes varied across cannabis-use frequency categories. Anxiety symptoms were reported by 47% of low-frequency users, 58% of weekly users, and 32% of daily users. Sleep disturbance was reported by 38%, 43%, and 33%, respectively, while memory complaints were reported by 20%, 12%, and 16%.

Reduced concentration was reported by 29% of low-frequency users, 26% of weekly users, and 19% of daily users. Mood changes were reported by 48%, 39%, and 30%, respectively. Psychotic-like symptoms were reported by 30% of low-frequency users, 39% of weekly users, and 37% of daily users.

Chi-square analysis showed statistically significant associations between cannabis-use frequency and anxiety symptoms ($p = 0.006$) and psychotic-like symptoms ($p = 0.017$). No statistically significant associations were observed for sleep disturbance, memory complaints, reduced concentration, or mood changes ($p > 0.05$). The detailed distribution of self-reported outcomes is presented in Table 4.

Table 4. Self-reported health outcomes according to cannabis-use frequency among adult male participants

Outcome	**Low-frequency use (%)**	**Weekly use (%)**	**Daily use (%)**	p-value
Anxiety symptoms	47	58	32	0.006*
Sleep disturbance	38	43	33	0.142
Memory complaints	20	12	16	0.206
Reduced concentration	29	26	19	0.176
Mood changes	48	39	30	0.131
Psychotic-like symptoms	30	39	37	0.017*

*Statistically significant at $p < 0.05$.

Psychotic-like symptoms refer to self-reported questionnaire responses and do not represent a clinical diagnosis.

4. Discussion

The present study integrated botanical observation, cannabinoid profiling, and cross-sectional health data to examine *Cannabis sativa* L. from both plant and public-health perspectives. The observed morphological characteristics, including palmately compound serrated leaves, a developmental shift from opposite to increasingly alternate phyllotaxy, erect ridged stems, sexually differentiated flowers, and visible resin accumulation around reproductive tissues, were consistent with established botanical descriptions of the species (Andre et al., 2016; Bonini et al., 2018; Fordjour et al., 2023; Simiyu et al., 2022).

The concentration of visible resin around female reproductive tissues is consistent with the known distribution of glandular trichomes in *Cannabis sativa*. These specialized epidermal structures represent major sites of cannabinoid and terpene biosynthesis, secretion, and storage, particularly on female inflorescences and surrounding bracts (Fordjour et al., 2023; Tanney et al., 2021; Xie et al., 2023). The macroscopic pattern observed in the present study therefore supports the established relationship between reproductive tissues and secondary-metabolite production.

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Chemical analysis showed a marked predominance of THCA (20.3 mg/g), while Δ9-THC was detected at 1.2 mg/g. Lower concentrations of CBDA, CBG, CBD, and CBN were also identified. The predominance of THCA is consistent with the phytochemistry of fresh or minimally processed cannabis material, in which acidic cannabinoid precursors may remain abundant before conversion to neutral cannabinoids through decarboxylation during heating, drying, storage, or aging (Fordjour et al., 2023; Pellati et al., 2018; Radwan et al., 2021). However, the cannabinoid profile obtained in this study represents the analyzed female inflorescences and should not be assumed to reflect the composition of cannabis products used by survey participants.

The human component of the study provides preliminary evidence on cannabis-related health outcomes among displaced adult males in the Gaza Strip. A large proportion of participants were living in tents, indicating that the study population was exposed to substantial contextual stressors. Psychological and cognitive outcomes in such settings may be influenced by multiple overlapping factors, including displacement, housing instability, disrupted sleep, socioeconomic stress, trauma exposure, and limited access to health services. Consequently, the observed associations should not be attributed to cannabis use alone.

Cannabis-use frequency was significantly associated with anxiety symptoms ($p = 0.006$) and psychotic-like symptoms ($p = 0.017$). In contrast, sleep disturbance, memory complaints, reduced concentration, and mood changes did not show statistically significant associations with use frequency. These findings suggest that selected psychological outcomes may vary according to cannabis-use patterns within the study population; however, the cross-sectional design does not establish temporal sequence or causality.

The finding related to psychotic-like symptoms is broadly consistent with international evidence indicating a frequency-dependent association between cannabis exposure and psychosis-related outcomes. Robinson et al. (2023) reported increasing risk estimates with weekly and daily cannabis use, while Marconi et al. (2016) similarly demonstrated a dose–response relationship between the level of cannabis exposure and psychosis risk. Kiburi et al. (2021) further reported that this relationship may be influenced by factors such as age at initiation, frequency of use, trauma exposure, co-use of other substances, and individual vulnerability. The present findings should nevertheless be interpreted cautiously because the reported psychotic-like symptoms were questionnaire-based and did not represent clinical diagnoses.

Palestinian evidence remains limited but provides an important contextual comparison. Damiri et al. (2024) reported THC positivity in 7.3% of urine samples among Palestinian males in the northern West Bank and identified significant associations between THC positivity and the use of alcohol, benzodiazepines, and methamphetamines. Their findings highlight the potential importance of polysubstance use and sociocultural factors in Palestinian populations. The present study differs in setting, sampling approach, exposure assessment, and measured outcomes, and the two studies should therefore not be interpreted as directly comparable prevalence estimates.

An important feature of the present study is the integration of plant-level and human-level evidence while maintaining analytical separation between them. Plant anatomy determines the distribution of resin-producing structures, chemical analysis characterizes the cannabinoid composition of the analyzed material, and human health outcomes depend on the actual products used, dose, frequency, route of administration, individual susceptibility, and contextual factors. These dimensions should therefore not be treated as equivalent unless the cannabis products used by participants are directly chemically characterized.

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4.1 Strengths and Limitations

A key strength of this study is the integration of botanical, chemical, and human health data within a single research framework. Direct plant observation, HPLC-DAD analysis, and cross-sectional survey data provided complementary evidence from the Gaza Strip.

The main limitations include the small male-only convenience sample (N = 59), reliance on self-reported cannabis use and health outcomes, and the absence of clinical diagnostic assessment. The cross-sectional design also prevents causal interpretation, and several potential confounding factors were not fully assessed. In addition, the cannabinoid profile of the analyzed plant material cannot be assumed to represent the cannabis products used by participants.

5. Conclusion

This study integrated botanical observation, HPLC-DAD cannabinoid profiling, and cross-sectional health data among adult males in the Gaza Strip. THCA was the predominant cannabinoid in the analyzed female inflorescences. Cannabis-use frequency was significantly associated with anxiety symptoms and psychotic-like symptoms. However, the cross-sectional design and self-reported outcomes limit causal interpretation and generalizability.

6. Recommendations

Future studies should include larger and more representative samples, use validated clinical assessment tools, and collect more detailed information on cannabis exposure. Where possible, direct chemical analysis of the cannabis products used by participants and longitudinal study designs are recommended.

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Declarations

Ethics approval and consent to participate:

The study was approved by the Emergency Committee in the Gaza Strip (Approval No. Med Sep. 2026/35; 28 September 2026). Informed consent was obtained from all participants before enrollment in the study.

Data availability:

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Conflict of interest:

The author declares no conflict of interest.

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References

[1] Andre, C. M., Hausman, J.-F., & Guerriero, G. (2016). Cannabis sativa: The plant of the thousand and one molecules. *Frontiers in Plant Science, 7*, 19. https://doi.org/10.3389/fpls.2016.00019

[2] Bonini, S. A., Premoli, M., Tambaro, S., Kumar, A., Maccarinelli, G., Memo, M., & Mastinu, A. (2018). Cannabis sativa: A comprehensive ethnopharmacological review of a medicinal plant with a long history. *Journal of Ethnopharmacology, 227*, 300–315. https://doi.org/10.1016/j.jep.2018.09.004

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[3] Damiri, B., Bilbeisi, S., MohammedAli, M., & Najjar, M. (2024). Cannabis use associated with high-risk drug use among Palestinians: An emerging health risk. *Population Medicine, 6*, 2. https://doi.org/10.18332/popmed/180979
[4] Fordjour, E., Manful, C. F., Sey, A. A., Javed, R., Pham, T. H., Thomas, R., & Cheema, M. (2023). Cannabis: A multifaceted plant with endless potentials. *Frontiers in Pharmacology, 14*, 1200269. https://doi.org/10.3389/fphar.2023.1200269
[5] Kiburi, S. K., Molebatsi, K., Ntlantsana, V., & Lynskey, M. T. (2021). Cannabis use in adolescence and risk of psychosis: Are there factors that moderate this relationship? A systematic review and meta-analysis. *Substance Abuse, 42*(4), 527–542. https://doi.org/10.1080/08897077.2021.1876200
[6] Marconi, A., Di Forti, M., Lewis, C. M., Murray, R. M., & Vassos, E. (2016). Meta-analysis of the association between the level of cannabis use and risk of psychosis. *Schizophrenia Bulletin, 42*(5), 1262–1269. https://doi.org/10.1093/schbul/sbw003
[7] Pellati, F., Borgonetti, V., Brighenti, V., Biagi, M., Benvenuti, S., & Corsi, L. (2018). Cannabis sativa L. and nonpsychoactive cannabinoids: Their chemistry and role against oxidative stress, inflammation, and cancer. *BioMed Research International, 2018*, 1691428. https://doi.org/10.1155/2018/1691428
[8] Radwan, M. M., Chandra, S., Gul, S., & ElSohly, M. A. (2021). Cannabinoids, phenolics, terpenes and alkaloids of cannabis. *Molecules, 26*(9), 2774. https://doi.org/10.3390/molecules26092774
[9] Robinson, T., Ali, M. U., Easterbrook, B., Hall, W., Jutras-Aswad, D., & Fischer, B. (2023). Risk-thresholds for the association between frequency of cannabis use and the development of psychosis: A systematic review and meta-analysis. *Psychological Medicine, 53*(9), 3858–3868. https://doi.org/10.1017/S0033291722000502
[10] Simiyu, D. C., Jang, J. H., & Lee, O. R. (2022). Understanding Cannabis sativa L.: Current status of propagation, use, legalization, and haploid-inducer-mediated genetic engineering. *Plants, 11*(9), 1236. https://doi.org/10.3390/plants11091236
[11] Tanney, C. A. S., Backer, R., Geitmann, A., & Smith, D. L. (2021). Cannabis glandular trichomes: A cellular metabolite factory. *Frontiers in Plant Science, 12*, 721986. https://doi.org/10.3389/fpls.2021.721986
[12] Xie, Z., Mi, Y., Kong, L., Gao, M., Chen, S., Chen, W., Meng, X., Sun, W., Chen, S., & Xu, Z. (2023). Cannabis sativa: Origin and history, glandular trichome development, and cannabinoid biosynthesis. *Horticulture Research, 10*(9), uhad150. https://doi.org/10.1093/hr/uhad150

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