“A CROSS-SECTIONAL STUDY ON THE PREVALENCE OF ORAL MANIFESTATIONS IN PATIENTS WITH TYPE 2 DIABETES MELLITUS RESIDING IN SELECTED URBAN AREAS OF BELAGAVI.”

BY

UNDERTAKING

PLAGIARISM ACCEPTED LETTER

ETHICAL CLEARANCE LETTER

LIST OF ABBREVIATIONS

- **AGEs** – Advanced Glycation End Products
- **BPL** – Below Poverty Line
- **DM** – Diabetes Mellitus
- **DMFS** – Decayed, Missing, and Filled Surfaces
- **FBS** – Fasting Blood Sugar
- **HbA1c** – Glycated Hemoglobin
- **NCD** – Non-Communicable Disease
- **OHA** – Oral Hypoglycemic Agents
- **PUC** – Pre-University Course
- **RAGE** – Receptor for Advanced Glycation End Products
- **RBS** – Random Blood Sugar
- **SD** – Standard Deviation
- **SPSS** – Statistical Package for the Social Sciences
- **T2DM** – Type 2 Diabetes Mellitus
- **UHC** – Urban Health Centre
- **WHO** – World Health Organization

ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder associated with multiple systemic complications, including a wide range of oral manifestations. Periodontal disease, dental caries, salivary dysfunction, and oral mucosal alterations are frequently observed in diabetic individuals and may adversely affect glycemic control and quality of life. Community-based data on the prevalence and determinants of these oral manifestations in urban Indian settings remain limited.

Objectives: [redacted]

Methods: [redacted]

Results: [redacted]

Conclusion: [redacted]

Keywords: Type 2 diabetes mellitus, Oral manifestations, Periodontitis, Gingival bleeding, DMFS, Dental caries, Oral health, Glycemic control, Xerostomia, Burning mouth sensation, Lifestyle habits.

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INTRODUCTION

INTRODUCTION

The World Health Organization (WHO) defines diabetes mellitus as a chronic metabolic disease characterized by elevated levels of blood glucose resulting from defects in insulin secretion, insulin action, or both (1). [redacted]

Burning mouth syndrome, taste disturbances (dysgeusia), and increased susceptibility to oral infections have also been linked to chronic hyperglycemia and neuropathic changes seen in diabetes. Neuropathy involving sensory nerves supplying the oral cavity can manifest as persistent burning sensations despite an absence of overt clinical lesions (8).

Such evidence can support integrated healthcare planning, enhance the understanding of oral-systemic interactions, and contribute to a holistic approach in managing the rapidly increasing burden of diabetes in urban Indian populations (10).

Epidemiology

Global Epidemiology

Diabetes mellitus has emerged as a major global health problem, affecting populations in both developed and developing countries. [redacted]

Epidemiology in India

Rapid urbanization, changes in diet, reduced physical activity, and genetic predisposition contribute significantly to this rising epidemic. [redacted] Poor glycemic control further increases the prevalence and severity of periodontal destruction, tooth loss, and oral mucosal infections in Indian communities (12).

Epidemiology in Karnataka

Karnataka, like the rest of India, is experiencing a rising burden of type 2 diabetes mellitus, particularly in urban districts. [redacted] Belagavi, being an important urban center, shows growing concern over undiagnosed diabetes and unrecognized oral manifestations, reinforcing the importance of community-based epidemiological studies (13).

AIMS AND OBJECTIVES

AIMS AND OBJECTIVES

Objective:

[redacted]

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Hyperglycemia accelerates oxidative stress, inflammation, and vascular impairment, all of which disrupt oral tissue homeostasis. [redacted]

[redacted]

[redacted]Recognizing the biological link between systemic dysregulation and oral pathology enables more effective prevention and management strategies in diabetic populations (15).

Classification of Diabetes Mellitus

- Type 1 diabetes marked by autoimmune β-cell destruction

[redacted]

[redacted]Type 2 diabetes, because of its prolonged progression and chronic inflammatory state, shows the highest prevalence of periodontal disease, salivary dysfunction, and mucosal pathology (16).

Pathophysiology of Type 2 Diabetes Mellitus

The pathophysiology of type 2 diabetes mellitus involves a complex interaction between insulin resistance, impaired insulin secretion, chronic inflammation, and metabolic dysregulation. [redacted] The pathophysiology therefore provides a mechanistic link between systemic metabolic disruption and the oral cavity (17).

Systemic Complications Relevant to Oral Health

Type 2 diabetes mellitus is associated with numerous systemic complications that directly influence oral health outcomes. [redacted] These systemic features collectively explain the high prevalence of periodontal disease, oral mucosal lesions, and delayed wound healing among diabetic individuals (18).

Oral Health and Diabetes Mellitus

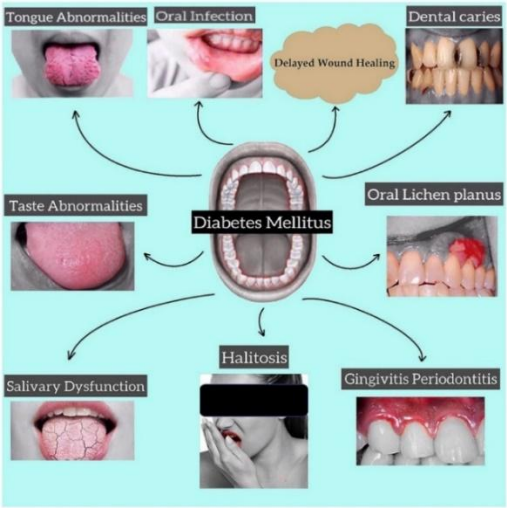


Fig 1: Oral Health and Diabetes Mellitus (20)

Biological link between diabetes and oral diseases

The biological connection between diabetes and oral diseases is rooted in complex metabolic, inflammatory, and vascular interactions. [redacted]

- Altered bone metabolism contributing to alveolar bone loss

Role of immune dysfunction in diabetes

The impaired immune response in diabetes also affects the ability to control fungal growth. [redacted]

- Excessive inflammation leading to periodontal tissue destruction

Microvascular and neuropathic changes affecting the oral cavity

Microvascular and neuropathic complications of diabetes mellitus significantly influence the health of oral tissues. [redacted]

- Impaired nerve function delaying detection of oral injury

Mechanisms Underlying Oral Complications in Diabetes

Impaired neutrophil function

Impaired neutrophil function is a central mechanism linking diabetes mellitus with increased susceptibility to oral diseases.

- Increased susceptibility to periodontal pathogens

Altered collagen metabolism

Collagen is a key structural component of gingival tissues, periodontal ligaments, and oral mucosa. [redacted]

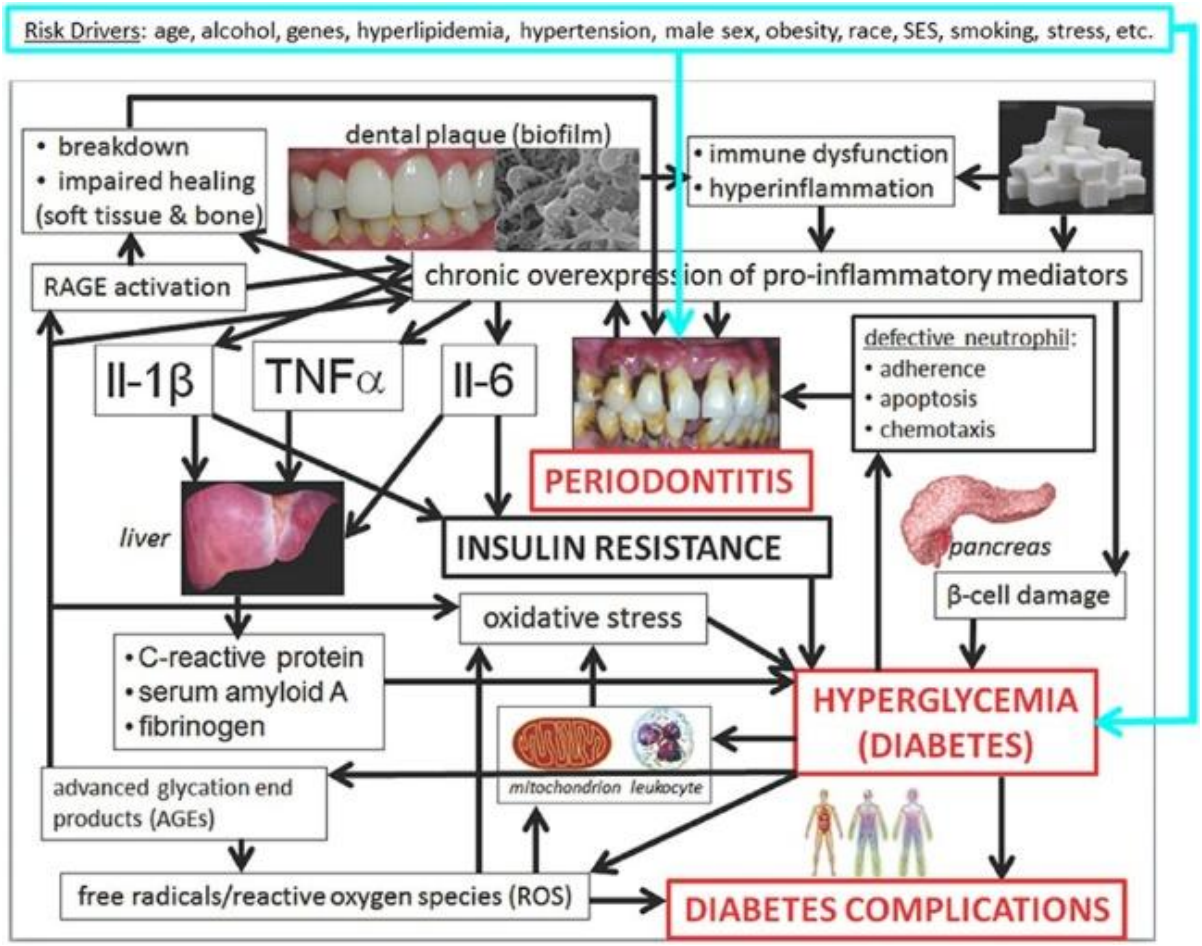


Fig 2: Diabetes and Oral Health (26)

Accumulation of advanced glycation end products (AGEs)

Advanced glycation end products accumulate in tissues as a consequence of prolonged hyperglycemia. [redacted] The understanding of AGEs provides a key biochemical explanation for why oral diseases in diabetic individuals progress more rapidly and respond poorly to conventional therapy (19).

Chronic inflammation and cytokine pathways

Chronic inflammation is a hallmark of diabetes mellitus and a major factor contributing to

oral disease progression. [redacted]

[redacted]

[redacted]Understanding cytokine-driven inflammatory pathways provides insight into the molecular basis of oral disease progression in diabetes and reinforces the importance of controlling systemic inflammation for oral health (5).

Salivary gland dysfunction

Salivary gland dysfunction is a well-recognized complication of diabetes mellitus and significantly influences oral health. [redacted]These

changes collectively result in impaired oral homeostasis and increase the likelihood of both infectious and inflammatory conditions (28).

Oral Manifestations in Type 2 DM

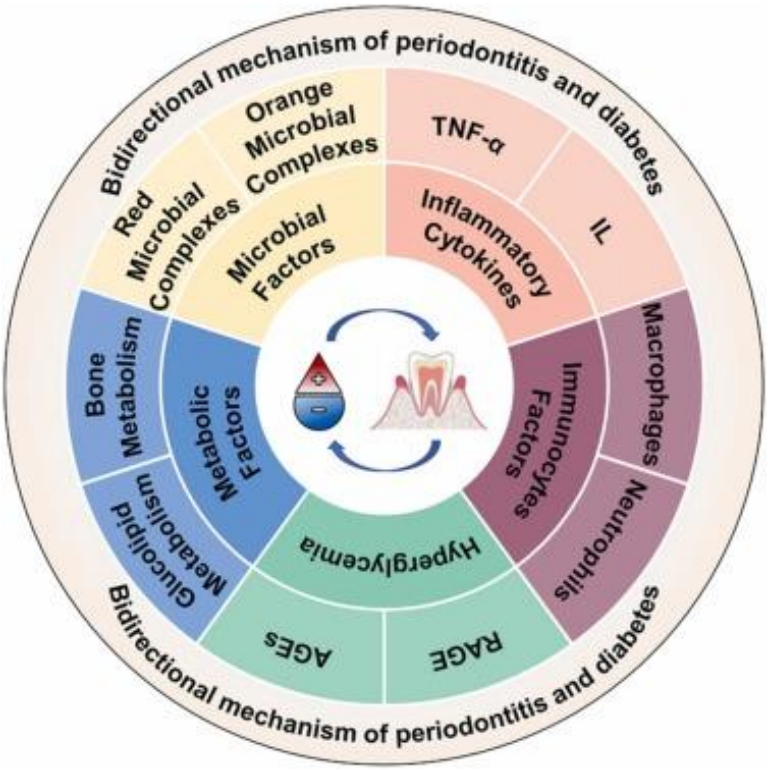


Fig 3: Relationship Between Periodinitis and Diabetes Mellitus (19)

Periodontal disease

Periodontal disease is one of the most significant oral complications associated with type 2 diabetes mellitus. [redacted]

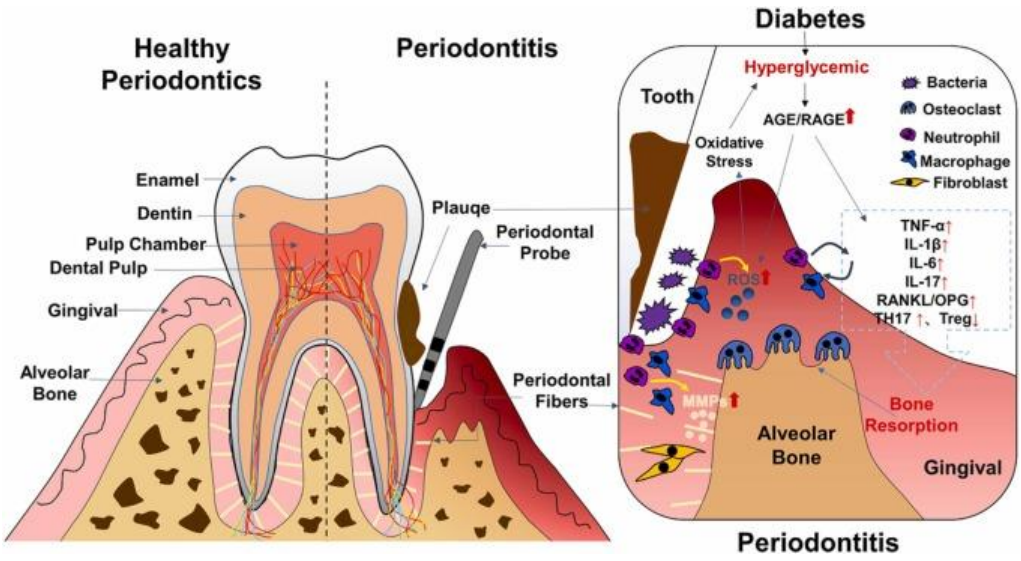


Fig 4: Periodontal Disease and Diabetes Mellitus (30)

Gingivitis

Gingivitis is an inflammatory condition of the gingival tissues and often serves as an early indicator of periodontal involvement in individuals with diabetes mellitus.

- Persistent bleeding due to immune dysregulation

Dental caries

Dental caries is a common complication in individuals with diabetes mellitus, influenced by metabolic changes, salivary alterations, and microbial shifts in the oral cavity.

- Enamel weakened by persistent acidic environment

Xerostomia

Xerostomia, or the subjective feeling of dry mouth, is one of the most prevalent oral manifestations of diabetes mellitus.

- Increased glucose concentration promoting irritation

Xerostomia and Salivary Alterations

Pathophysiology of reduced salivary secretion

Reduced salivary secretion in diabetic individuals arises from a complex combination of metabolic, vascular, neural, and glandular alterations.

[redacted]

- Oxidative stress affecting glandular cell viability

Oral candidiasis

Oral candidiasis is a frequent opportunistic infection in individuals with diabetes mellitus, resulting from impaired immune defenses, altered salivary function, and elevated salivary glucose levels. [redacted]

- Altered microbiome balance favoring fungal dominance

Immunological mechanisms

Immunological mechanisms play a central role in the development of oral fungal infections in individuals with diabetes mellitus. [redacted]

Together, these immunological disruptions explain why diabetic individuals experience more frequent, severe, and recurrent fungal infections (37).

Increased fungal colonization in diabetics

Diabetic individuals exhibit significantly increased fungal colonization in the oral cavity, primarily due to metabolic, immunological, and salivary dysfunctions.

- Enhanced adhesion and biofilm formation under hyperglycemia

Clinical presentations

Oral fungal infections in diabetic individuals present in several clinical forms, the most common being pseudomembranous candidiasis, erythematous candidiasis, and angular cheilitis.

- Recurrence linked to poor glycemic control

Impact of hyperglycemia on fungal proliferation

Hyperglycemia significantly accelerates fungal proliferation in the oral cavity and is one of the strongest predictors of candidiasis severity in diabetic individuals.

- Weakened neutrophil activity allowing rapid spread

Burning mouth syndrome

Burning mouth syndrome is a neuropathic condition frequently reported in individuals with diabetes mellitus.

- Altered taste perception accompanying burning sensations

Taste disturbances (dysgeusia)

Taste disturbances, commonly referred to as dysgeusia, are frequently reported among individuals with diabetes mellitus and represent an important sensory alteration linked to metabolic and neuropathic changes.

- Electrolyte and metabolic disturbances influencing taste perception

Periapical infections

Periapical infections involve inflammation and microbial invasion of tissues surrounding the apex of a tooth root, typically resulting from untreated dental caries or pulp necrosis.

[redacted]

- Delayed healing reducing endodontic success

Delayed wound healing

Chronic inflammation in diabetes also impedes the transition from inflammatory to proliferative phases of healing. [redacted]

- Microvascular impairment delaying epithelial closure

Oral mucosal lesions

Oral mucosal lesions are commonly observed in individuals with diabetes mellitus and arise from metabolic, immune, and vascular abnormalities. [redacted]

- microvascular impairment limiting repair

Halitosis

Halitosis, or unpleasant breath odor, is a common oral complaint among individuals with diabetes mellitus and results from both local and systemic factors. [redacted]

- Systemic metabolic disturbances affecting breath odor

Periodontal Disease in Diabetes Mellitus

Etiopathogenesis in diabetic individuals

The etiopathogenesis of periodontal disease in diabetic individuals involves a complex interaction of metabolic, inflammatory, immune, and microbial factors.

[redacted]

[redacted] Understanding etiopathogenesis is crucial for developing tailored preventive strategies and therapeutic interventions in diabetic individuals, ensuring early detection and management of periodontal involvement (4).

Bidirectional relationship with glycemic control

The association between diabetes mellitus and periodontal disease is strongly bidirectional, meaning that each condition influences the onset and progression of the other. [redacted]

- Chronic inflammation perpetuating metabolic dysregulation

Biological basis of enhanced susceptibility

Enhanced susceptibility to periodontal disease in diabetic individuals arises from several biological mechanisms involving immune dysfunction, impaired tissue metabolism, salivary

alterations, and vascular changes. [redacted]

- Pathogenic microbial shifts enhancing disease progression

Consequences including tooth mobility and tooth loss

Periodontal disease in diabetic individuals often leads to serious clinical consequences, including tooth mobility and eventual tooth loss. [redacted]

- Microbial invasion promoting rapid breakdown

Dental Caries in Diabetic Patients

Effect of reduced salivary flow

Reduced salivary flow is a prominent oral complication in individuals with diabetes mellitus and significantly influences oral comfort, hygiene, and disease susceptibility. [redacted]

- Altered composition weakening protective functions

Altered oral microbial flora

Diabetes mellitus profoundly alters the composition of oral microbial flora, increasing the prevalence of pathogenic organisms and disrupting the balance between beneficial and harmful microbes.

[redacted]

- Microbial dysbiosis enhancing inflammatory responses

Caries risk in poorly controlled diabetics

Poorly controlled diabetes significantly increases the risk of dental caries due to a combination of metabolic disturbances, salivary dysfunction, and microbial changes. [redacted]

- Persistent hyperglycemia accelerating enamel demineralization

Relationship between sugar metabolism and caries activity

The relationship between sugar metabolism and caries activity is particularly important in diabetic individuals due to the close connection between dietary sugars, microbial activity, and metabolic control. [redacted]

[redacted]

- Reduced remineralization enhancing enamel vulnerability

Autonomic neuropathy implications

Autonomic neuropathy is a major complication of long-standing diabetes mellitus and plays a crucial role in the development of oral dryness, altered taste, and impaired mucosal lubrication. [redacted]

[redacted]

Recognizing the oral signs of autonomic neuropathy provides an opportunity for early identification and management of systemic neuropathic progression (46).

Functional impact on mastication and swallowing

Reduced salivary flow, neuropathic changes, and mucosal dryness significantly affect

mastication and swallowing in diabetic individuals. [redacted]

- Reduced early digestion affecting texture and taste

Complications arising from chronic dry mouth

Chronic dry mouth, or persistent xerostomia, leads to numerous complications that affect comfort, oral function, and disease susceptibility in diabetic individuals. [redacted]

Recognizing the wide-ranging consequences of chronic dry mouth emphasizes its importance as a critical component of oral health management in diabetes (44).

Trigeminal nerve involvement

Trigeminal nerve involvement is a significant neuropathic complication observed in diabetic individuals and affects oral sensation, pain perception, and motor coordination.

- Altered periodontal sensation impairing detection of disease

Sensory alterations due to chronic hyperglycemia

Chronic hyperglycemia leads to widespread sensory alterations in diabetic individuals, affecting various components of the oral cavity.

- Altered nociception affecting protective reflexes

Oral Mucosal Lesions in Diabetes Mellitus

Lichen planus

Lichen planus is a chronic inflammatory mucocutaneous disorder frequently observed in individuals with diabetes mellitus, and its presence is believed to be influenced by immune dysregulation, metabolic stress, and mucosal vulnerability. [redacted]

- [redacted]
- Delayed mucosal repair linked to hyperglycemia

Traumatic ulcers

Traumatic ulcers occur more frequently and heal more slowly in diabetic individuals due to impaired mucosal resilience, reduced salivary lubrication, neuropathic deficits, and compromised wound-healing mechanisms. [redacted]

- Chronic inflammation delaying tissue repair

Mucosal pigmentation changes

Mucosal pigmentation changes are observed more frequently in diabetic individuals and may result from metabolic alterations, chronic inflammation, medication use, or endocrine dysfunction associated with the disease.

- Microvascular impairment affecting mucosal tone

Atrophic mucosal changes due to salivary alterations

Atrophic mucosal changes are common in diabetic individuals and are closely linked to chronic salivary alterations, particularly reduced salivary flow, decreased lubrication, and altered salivary composition. [redacted]

- Prolonged dryness leading to chronic irritation

Salivary Composition and Functional Changes

Altered pH and buffering capacity

Altered salivary pH and buffering capacity are significant biochemical changes observed in individuals with diabetes mellitus, resulting from metabolic disturbances, reduced salivary flow, and changes in salivary composition. [redacted]

- Salivary dysfunction reducing overall stability

Increased salivary glucose concentration

Increased salivary glucose concentration is a hallmark biochemical change in diabetic individuals and contributes significantly to the development of oral diseases. Understanding the significance of salivary glucose helps clinicians detect early biochemical markers of oral disease in diabetic individuals (52).

Effects on enamel remineralization

Enamel remineralization is significantly affected in individuals with diabetes mellitus due to changes in salivary composition, pH, and buffering capacity.

Understanding the impact of diabetes on remineralization underscores the importance of maintaining salivary health to prevent enamel breakdown (53).

Impact on oral microbiome balance

The oral microbiome undergoes significant alterations in diabetic individuals due to elevated salivary glucose, reduced salivary flow, and shifts in pH.

Recognizing the microbiome shifts in diabetes allows clinicians to intervene early and prevent complications (20).

Influence of Glycemic Control on Oral Health

Differences between controlled and uncontrolled diabetes

Controlled and uncontrolled diabetes differ substantially in their metabolic impact, systemic consequences, and oral manifestations.

- Microvascular damage limiting mucosal repair

HbA1c correlation with oral manifestations

HbA1c reflects long-term glycemic control over approximately three months and serves as a strong predictor of oral disease severity in diabetic individuals. [redacted]

[redacted]Improved glycemic control significantlyreduces oral complications, emphasizing HbA1c as a key biomarker in interdisciplinary diabetes care (54).

Inflammatory burden and tissue destruction

Diabetes significantly elevates systemic and local inflammatory burden, contributing directly to tissue destruction in the oral cavity. [redacted]

Understanding the relationship between inflammation and tissue destruction emphasizes the need for early intervention and metabolic optimization in diabetic oral care (19).

Reversibility of oral symptoms with improved control

Improved glycemic control has a significant positive impact on reversing or reducing many oral manifestations associated with diabetes mellitus. Periodontal health improves through reduced pocket depth, decreased bleeding, and slower attachment loss when glycemic control is sustained (37).

Risk Factors Modifying Oral Manifestations in Type 2 DM

Duration of diabetes

The duration of diabetes plays a critical role in determining the severity and progression of oral manifestations.

[redacted]

- Prolonged salivary dysfunction amplifying dryness

Smoking and tobacco use

Smoking and tobacco use significantly worsen oral manifestations in individuals with diabetes. [redacted]

[redacted]

Understanding the synergistic damage caused by tobacco underscores its role as a major exacerbating factor (55).

Alcohol intake

Alcohol intake influences oral health in diabetic individuals by altering metabolic stability, dehydrating mucosal surfaces, and modifying immune responses. [redacted]

[redacted]

[redacted]Understanding alcohol's role helps clinicians address a preventable contributor to oral complications in diabetic patients (56).

Oral hygiene practices

Oral hygiene plays a crucial role in modifying the severity of oral manifestations in diabetic individuals. [redacted]

[redacted]

[redacted] Understanding the role of hygiene emphasizes its importance as a modifiable factor in diabetic oral care (16).

Comorbid systemic conditions

Comorbid systemic conditions frequently coexist with diabetes and influence its oral manifestations. [redacted] Medications used to manage comorbidities may also reduce salivary flow or alter taste perception (57).

Medication-related oral effects

Medications used in diabetes management and accompanying systemic conditions have significant effects on oral health. [redacted]

- Polypharmacy increasing side-effect risk

Impact on nutrition and mastication

Oral manifestations of diabetes significantly affect nutrition and mastication by altering the mechanical, sensory, and functional components of eating. [redacted]

- Taste alterations influencing dietary patterns

Quality of life considerations

Diabetes-related oral manifestations significantly decrease quality of life by affecting comfort, function, aesthetics, and social interaction. Persistent dryness, burning sensations, and mucosal pain reduce enjoyment of daily activities such as eating, drinking, and speaking (41).

Importance of oral health for metabolic control

Oral health plays an essential role in maintaining metabolic control in individuals with diabetes. [redacted] Conversely, untreated oral infections such as candidiasis or periapical pathology increase systemic inflammatory load, worsening metabolic imbalance (2).

Importance of Early Detection of Oral Manifestations

Role of primary care physicians

Primary care physicians play a central role in the early identification, prevention, and

management of oral manifestations in individuals with diabetes. [redacted] Primary care physicians coordinate treatment plans, adjust medications that may cause salivary reduction, and refer patients for dental evaluation when early symptoms arise (59).

Role of dentists in diabetes management

Dentists play a crucial role in detecting early oral signs of diabetes, managing complications, and supporting metabolic stability. [redacted]

- Communication with physicians to monitor metabolic status

Preventive strategies for oral complications

Preventive strategies are essential for reducing the risk and severity of oral complications in diabetic individuals. [redacted]

- Avoidance of tobacco and alcohol to minimize dryness

Importance of screening diabetic patients for oral diseases

Screening diabetic patients for oral diseases is an essential component of comprehensive diabetes management due to the strong bidirectional relationship between metabolic control and oral health.

- Enhanced prevention reducing systemic complications

Barriers to oral healthcare in urban diabetic populations

Urban diabetic populations often face multiple barriers that limit access to timely and adequate oral healthcare.

Understanding barriers helps design effective urban health policies that improve access and outcomes (61).

Relevance for public health and Community Medicine

The oral health challenges faced by diabetic individuals are of major importance to public health and Community Medicine because they reflect broader issues of chronic disease management, access to care, and health education.

Community Medicine plays a crucial role in designing policies and interventions tailored to local needs, ensuring that oral health becomes a core component of chronic disease management (62).

Need for local area–specific evaluation

Local evaluation provides essential data on awareness levels, screening rates, oral hygiene practices, and prevalence of conditions such as xerostomia, candidiasis, periodontal disease, and mucosal lesions.

Recognizing the need for local evaluation ensures that oral health interventions for diabetic individuals in Urban Belagavi are relevant, efficient, and impactful (63).

Rationale for the Present Study

Diabetes mellitus is strongly associated with a wide range of oral manifestations, including periodontal disease, xerostomia, candidiasis, burning mouth sensations, mucosal lesions, and altered taste.

[redacted]

This study aims to generate baseline information on the prevalence of oral manifestations among type 2 diabetic patients in selected areas of Urban Belagavi, supporting better integration of oral health into diabetes care.

Updated prevalence data

- Globally, the number of adults with diabetes is estimated at around 537 million (2020) and projected to rise to about 783 million by 2045.
- [redacted]
- For the state of Karnataka, a recent study (November 2025) indicates a steady diabetes burden, though a precise current prevalence figure for the general population was not given in that source.

Research Studies

[redacted]**., (2025)** explores the bidirectional relationship between chronic periodontitis and type 2 diabetes mellitus with a particular focus on systemic inflammation and glycaemic control. The authors describe how periodontal infection contributes to a persistent inflammatory burden, elevating circulating cytokines and reactive oxygen species that can worsen insulin resistance and make glycaemic control more difficult. [redacted] The article concludes that periodontitis should be regarded as a chronic inflammatory comorbidity of diabetes, and that routine periodontal screening, patient education on oral hygiene, and collaboration between dentists and diabetologists are essential parts of comprehensive diabetes care (5).

[redacted]**., (2025)** compares oral health status and self-care practices in adults with diabetes and non-diabetic controls. The authors assess several clinical indicators, including plaque accumulation, gingival inflammation, periodontal status and caries experience, alongside behavioural variables such as tooth-brushing frequency, use of interdental aids, dental visits and dietary habits. [redacted]The authors recommend closer collaboration between primary care, endocrinology and dentistry to ensure that oral health assessments become a routine component of diabetes reviews, and that patients receive simple, actionable messages about preventing gum disease and caries (10).

[redacted] **(2025)** quantifies the burden of oral diseases among patients with type 2 diabetes mellitus attending dental or medical facilities. The authors document the prevalence of common oral manifestations such as gingivitis, chronic periodontitis, dental caries, xerostomia, oral candidiasis and mucosal lesions. [redacted]The authors call for regular oral screening in diabetic clinics, patient education regarding daily plaque control, and simple chairside counselling on diet and tobacco cessation, emphasising that addressing oral

disease can improve comfort, mastication and overall quality of life for people with diabetes (11).

[redacted] **(2025)** investigates the impact of diabetes mellitus on patients diagnosed with oral lichen planus (OLP), an oral potentially malignant disorder characterised by chronic inflammation of the mucosa. The authors compare clinical presentation, distribution of lesions, symptom severity and disease course between OLP patients with diabetes and those without. [redacted] It supports a multidisciplinary approach in which dentists, oral medicine specialists and physicians collaborate to optimise systemic control and local therapy (49).

[redacted]**, (2024)** review synthesises current evidence on the influence of diabetes mellitus on oral health. The author outlines how chronic hyperglycaemia contributes to a wide spectrum of oral complications, including periodontal disease, dental caries, xerostomia, burning mouth sensations, candidiasis, delayed wound healing and various mucosal lesions. [redacted]

The review concludes that oral health is an integral component of comprehensive diabetes care and that increased awareness among both clinicians and patients is necessary to reduce the burden of oral complications (9).

l., (2024) examines the complex interplay between diabetes mellitus and periodontal, pulpal and periapical diseases. The authors describe how chronic hyperglycaemia impacts not only periodontal tissues but also the pulp–periapical complex through microangiopathy, impaired immune function and collagen turnover abnormalities.

For clinicians, the article highlights that dental infections in patients with diabetes should be treated promptly and comprehensively, as unresolved chronic oral infection can compromise overall health and diabetes management (3).

(2023) focuses on the bidirectional relationship between periodontal disease and diabetes mellitus. The authors synthesise epidemiological data demonstrating that people with diabetes have a higher prevalence and severity of periodontitis, and that the presence of periodontitis is associated with worse glycaemic control and greater risk of diabetes-related complications.

[redacted] The review positions periodontal disease as a recognised complication of diabetes and supports the inclusion of oral health considerations in clinical guidelines for diabetes management (2).

[redacted] **(2023)** provides mechanistic insight into how diabetes mellitus promotes susceptibility to periodontitis. Rather than focusing primarily on clinical prevalence, the authors review molecular and cellular changes in immune and structural cells within periodontal tissues exposed to a hyperglycaemic environment. [redacted] The authors suggest potential therapeutic targets, such as antioxidant strategies, modulation of specific signalling pathways and host-response modulation, to complement conventional mechanical periodontal therapy, particularly in poorly controlled diabetic patients (4).

[redacted] **(2023)** reviews burning mouth syndrome (BMS), a chronic oral pain condition characterised by a burning sensation of the tongue or other mucosal surfaces in the absence of obvious clinical lesions. The text classifies BMS into primary (idiopathic) and secondary forms, the latter associated with systemic or local factors such as nutritional deficiencies, hormonal changes, medications and systemic diseases including diabetes mellitus. [redacted]

[redacted] For oral health research in diabetes, this resource clarifies that burning sensations or taste disturbances reported by diabetic patients may represent BMS or BMS-like secondary symptoms, and that careful evaluation is needed to differentiate these from other oral manifestations such as candidiasis or OLP (8).

[redacted]**, (2021)** discusses the wide range of oral conditions associated with diabetes mellitus, emphasising their clinical relevance and implications for patient care. The authors describe periodontal disease, dental caries, xerostomia, oral candidiasis, burning mouth sensations, delayed wound healing and various mucosal lesions as key manifestations. [redacted] Educational messages about oral hygiene, tobacco cessation and diet are positioned as necessary components of diabetes counselling (16).

[redacted]**., (2019)** evaluates all potential oral complications of diabetes mellitus, assembling evidence from epidemiological, clinical and mechanistic studies. The authors catalogue periodontal diseases, dental caries, salivary gland dysfunction, taste disturbances, burning mouth symptoms, oral candidiasis and mucosal disorders such as lichen planus and geographic tongue as conditions more frequently reported in diabetic populations. [redacted]

[redacted] For clinicians and researchers, this article serves as a broad reference summarising the spectrum of oral alterations relevant to diabetic patients (14).

[redacted]**., (2019)** determines the prevalence of periodontal disease among patients with type 2 diabetes mellitus. The authors record standard periodontal parameters such as probing depth, clinical attachment loss, bleeding on probing and plaque scores, and classify disease severity according to recognised criteria. [redacted] They conclude that periodontal disease should be viewed as a common comorbidity in type 2 diabetes and that routine periodontal examination and appropriate therapy are crucial components of comprehensive diabetic care (12).

[redacted] **(2019)** review summarises the range of oral manifestations observed in patients with diabetes mellitus. It covers soft-tissue changes such as gingivitis, periodontitis, xerostomia, burning mouth sensation, candidiasis, angular cheilitis and lichen planus, as well as hard-tissue problems like increased caries risk and delayed post-extraction healing. [redacted] Overall, the article reinforces that oral health assessment and promotion are integral parts of diabetes management (41).

[redacted]., **(2018)** investigates the relationship between salivary glucose levels and oral candidal carriage in patients with type 2 diabetes mellitus. Unstimulated or stimulated saliva samples are collected from diabetic participants and possibly non-diabetic controls, and analysed for glucose concentration, while oral swabs or rinses are used to quantify Candida colonisation. [redacted] Clinically, the findings emphasise the importance of monitoring for signs of candidal infection in patients with diabetes, especially those complaining of burning, soreness or removable denture discomfort, and of reinforcing both glycaemic control and oral hygiene measures to reduce fungal overgrowth (28).

[redacted] **(2018)** evaluates the relationship between dental caries, diabetes mellitus and oral microbiota in diabetic patients. The authors record caries experience, likely using standard indices, and compare these findings with microbiological data from saliva or plaque samples, assessing the presence and levels of cariogenic bacteria. [redacted] Recommendations include comprehensive caries risk assessment for diabetic individuals, emphasis on fluoride use, dietary counselling and regular professional monitoring to prevent progression of disease (31).

[redacted] **(2017)** investigates the association between the number of microvascular complications of diabetes and the severity of periodontitis in patients with type 2 diabetes. The authors classify participants according to the presence of retinopathy, nephropathy and neuropathy,

and assess periodontal status using clinical attachment loss, pocket depth and bleeding indices. [redacted] The authors conclude that periodontal status may serve as an additional marker of systemic disease severity in diabetes and that patients with microvascular complications should routinely undergo thorough periodontal examination and treatment (17).

[redacted] **(2016)** identifies Candida species present in the oral cavity of diabetic patients and evaluates their potential pathogenic significance. Oral swab or rinse samples are collected from individuals with diabetes and cultured to identify species such as Candida albicans, C. [redacted] The study reinforces the link between metabolic control and susceptibility to opportunistic oral infections (38).

[redacted]**., (2016)** evaluates oral manifestations in patients with diabetes mellitus at a tertiary care hospital in North Karnataka. The authors document a range of oral findings including gingivitis, periodontitis, xerostomia, dental caries, candidiasis, geographic tongue, lichen planus and ulcerative lesions, and compare their frequency with non-diabetic individuals or across subgroups of diabetics. [redacted]

[redacted] The authors advocate routine oral screening for diabetic patients, emphasise patient education on plaque control and advise collaboration between physicians and dental professionals to improve early detection and management of oral complications (13).

[redacted] **(2014)** assesses the prevalence of oral mucosal alterations in patients with type 2 diabetes mellitus attending a diabetic centre. The authors perform detailed intraoral examinations and record a variety of mucosal changes such as fissured tongue, coated tongue, lichen planus, leukoplakia, geographic tongue, traumatic ulcers and manifestations of candidiasis. [redacted] The article supports increased collaboration between endocrinologists and dentists or oral medicine specialists to ensure timely diagnosis and management of these conditions (51).

[redacted] **(2011)** provides an overview of oral manifestations and complications associated with diabetes mellitus, drawing on clinical and experimental studies. The authors describe periodontal disease as one of the most consistent findings, detailing how diabetics show higher prevalence and severity of attachment loss, pocketing and tooth loss. [redacted] The article underscores that oral manifestations may be the first sign of undiagnosed diabetes in some individuals, and it encourages dental practitioners to be

vigilant and to liaise with physicians when systemic disease is suspected (44).

[redacted]**., (1992)** examines xerostomia in individuals with diabetes mellitus. The authors assess subjective reports of dry mouth and objectively measure salivary flow rates, comparing diabetic patients with non-diabetic controls. [redacted] This work laid the groundwork for later studies on salivary involvement in diabetic oral complications (6).

MATERIALS AND METHODS

MATERIALS AND METHODS

Source of Data [redacted]

Study Design: [redacted]

Study Period: [redacted]

Sample Size: [redacted]

Sampling Technique: [redacted]

Inclusion Criteria: [redacted]

Exclusion Criteria:

1. All type 1 diabetes patients

   [redacted]

3. Patients taking any immunosuppressants

Study Protocol: [redacted]

Data Collection Procedure: Data collection was carried out among all registered type 2 diabetes mellitus patients belonging to the Ashok Nagar and Rukmini Nagar service areas under their respective Urban Health Centres (UHCs) in Belagavi. A list of eligible diabetic patients was first obtained from the updated Non-Communicable Disease (NCD) registers maintained at both UHCs. [redacted]

[redacted]

[redacted]

[redacted]

software for Microsoft Windows. Rates were expressed as percentages. Statistical analysis was performed using Chi-square test and multiple logistic regression.

RESULTS

RESULTS

Table 1: Distribution of subjects according to demographic details.

Variable	Subcategory	n	%
Age	Mean ± SD	[redacted]	
	Median (Min, max)	[redacted]	
Gender	Female	[redacted]	[redacted]
	Male	[redacted]	[redacted]
Religion	Christian	[redacted]	[redacted]
	Hindu	[redacted]	[redacted]
	Muslim	[redacted]	[redacted]
Education	Graduation	[redacted]	[redacted]
	High school, PUC or Diploma	[redacted]	[redacted]
	Illiterate	[redacted]	[redacted]
	Primary	[redacted]	[redacted]
Family type	Joint	[redacted]	[redacted]
	Nuclear	[redacted]	[redacted]
Socio-economic status	IV	[redacted]	[redacted]
	V	[redacted]	[redacted]
BPL card holder	Yes	[redacted]	[redacted]
	NA	[redacted]	[redacted]
Over crowding	Yes	[redacted]	[redacted]
	No	[redacted]	[redacted]

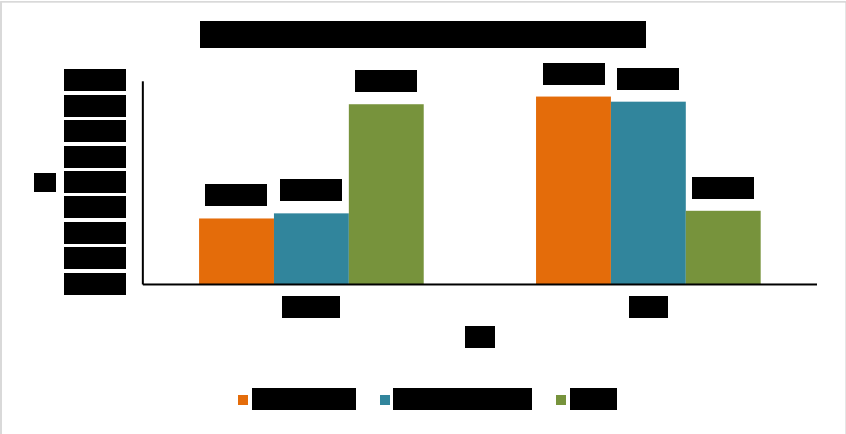
Graph 1: Distribution of subjects according to demographic details.

Taken together, these findings indicate that the majority of T2DM patients belonged to an economically weaker, educationally less privileged, middle-aged population suggesting a need for targeted oral health interventions and awareness programs focusing on these vulnerable groups.

Table 2: Oral manifestations Distribution according to Gender

Sex	Periodontitis (n)	%	Gingival Bleeding (n)	%	DMFS (n)	%
Female	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Male	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Graph 2: Oral manifestations Distribution according to Gender

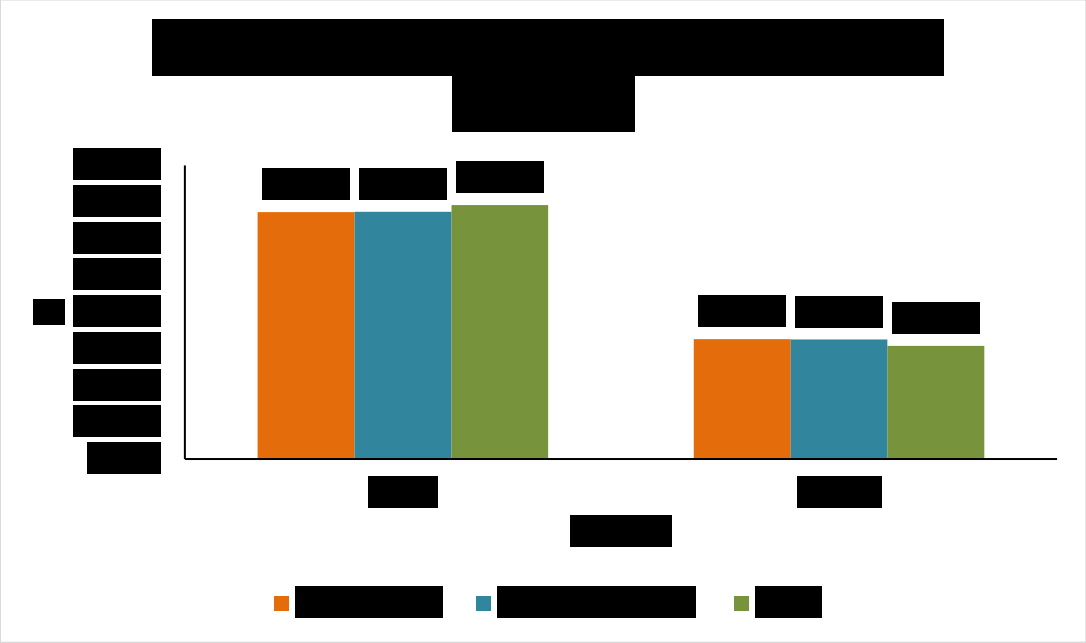


A total of 168 patients were diagnosed with periodontitis, 178 presented with gingival bleeding, and 117 showed DMFS involvement. [redacted] These observations highlight the need for gender-tailored preventive strategies focusing on periodontal care in men and caries prevention in women.

Table 3: Oral manifestations Distribution by Religion

Religion	Periodontitis (n)	%	Gingival Bleeding (n)	%	DMFS (n)	%
Hindu	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Muslim	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Graph 3: Oral manifestations Distribution according to Religion



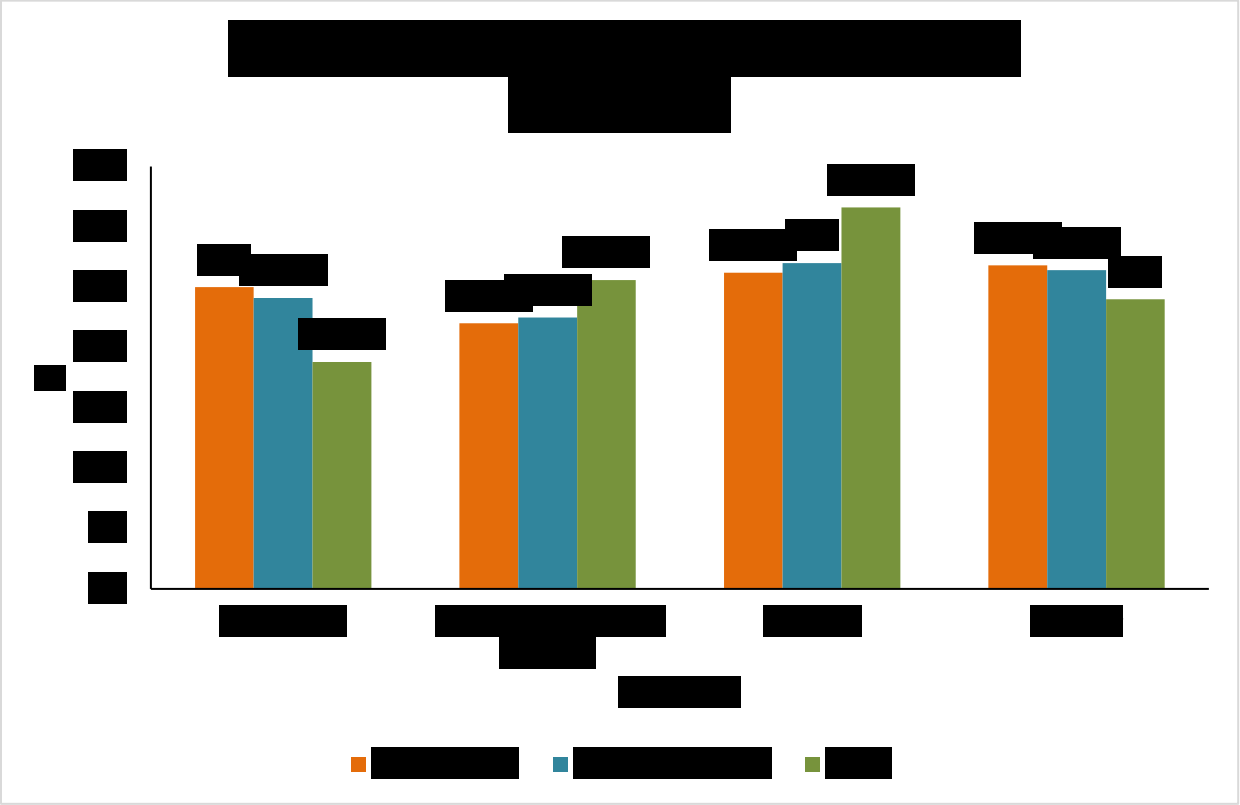
The study population showed that Hindu participants exhibited a substantially higher proportion of oral manifestations compared to Muslim participants. [redacted]

Overall, the data highlights the need for targeted oral health education and preventive initiatives across all religious groups, especially focusing on the predominant community where the burden of disease is highest.

Table 4: Oral manifestations Distribution according to Education

Education	Periodontitis (n)	%	Gingival Bleeding (n)	%	DMFS (n)	%
Graduation	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
High School, PUC or Diploma	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Illiterate	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Primary	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Graph 4: Oral manifestations Distribution by Education



The findings indicate that individuals with lower educational levels experience a higher burden of oral diseases. [redacted]

[redacted]

[redacted]

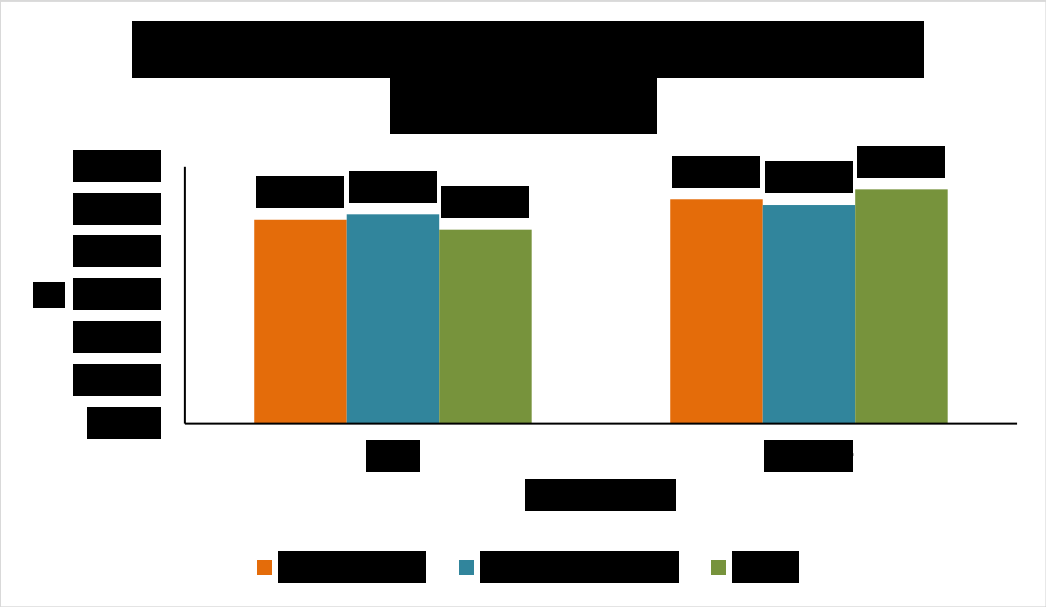
[redacted]

Thus, education plays an important role in determining oral health status, emphasizing the need for focused health education and awareness interventions in lower-literacy populations to reduce complications related to diabetes.

Table 5: Oral manifestations Distribution according to Family Type

Family Type	Periodontitis (n)	%	Gingival Bleeding (n)	%	DMFS (n)	%
Joint	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Nuclear	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Graph 5: Oral manifestations Distribution according to Family Type



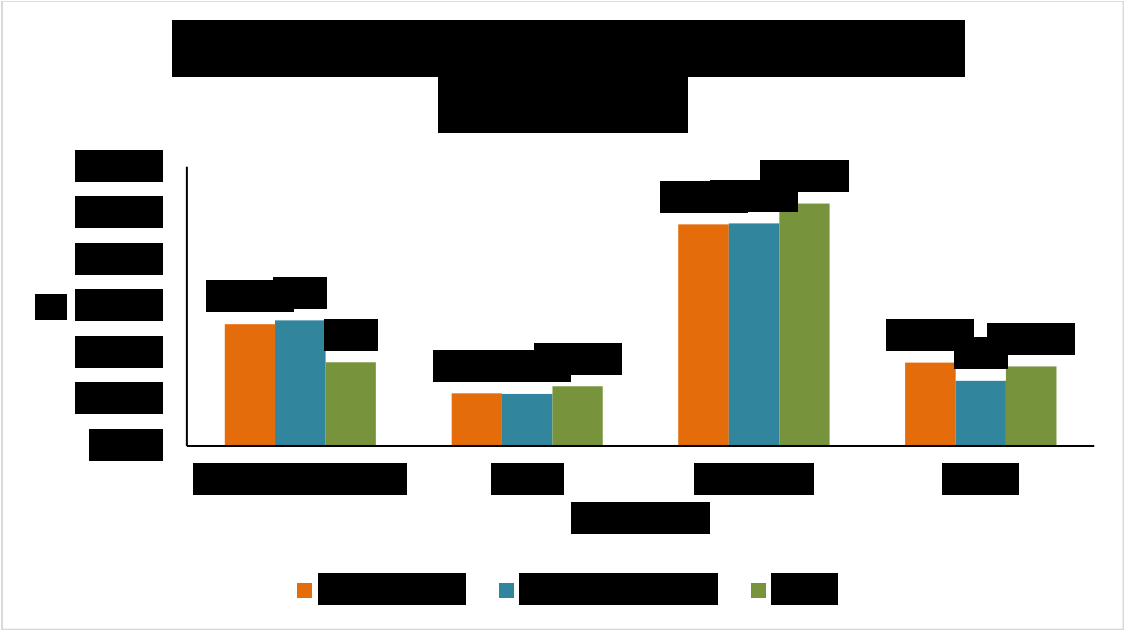
[redacted]

Overall, these findings indicate a requirement for enhancing oral health promotion and family-based preventive strategies, especially in nuclear family households where risk appears slightly elevated.

Table 6: Oral manifestations Distribution according to Occupation

Occupation	Periodontitis (n)	%	Gingival Bleeding (n)	%	DMFS (n)	%
Daily wage worker	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Driver	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Housewife	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Others	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Graph 6: Oral manifestations Distribution according to Occupation



[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

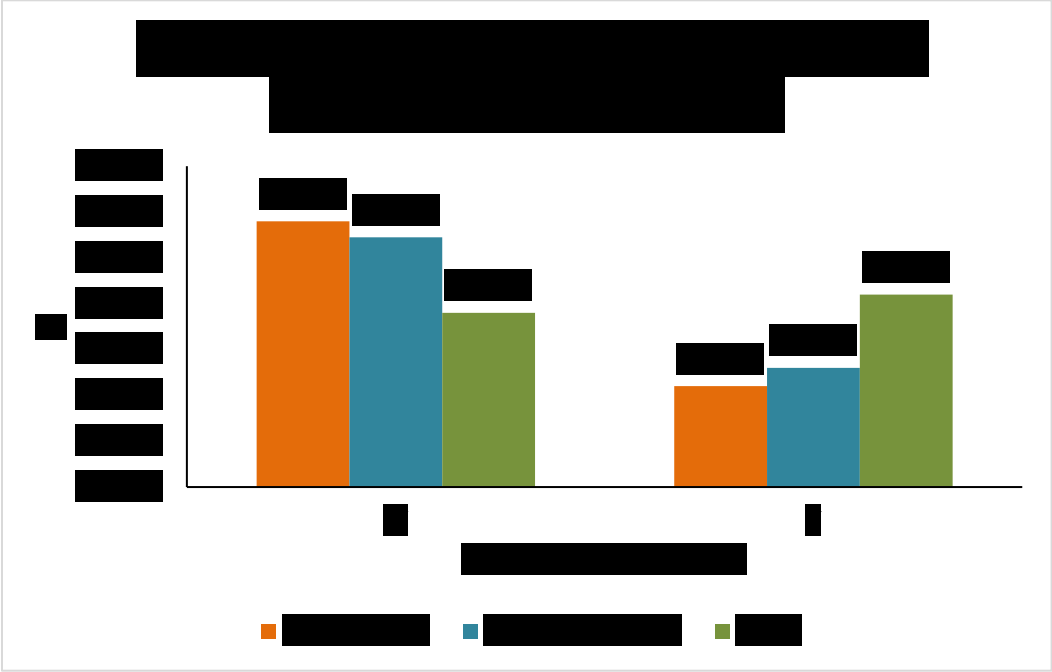
[redacted]

Occupational status therefore emerges as an important determinant in oral health among diabetic individuals, emphasizing the need for targeted awareness and preventive intervention programs focusing particularly on homemakers and lower-income working groups.

Table 7: Oral manifestations Distribution according to Socio - Economic Status

Socio - Economic Status	Periodontitis (n)	%	Gingival Bleeding (n)	%	DMFS (n)	%
IV	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
V	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Graph 7: Oral manifestations Distribution according to Socio - Economic Status



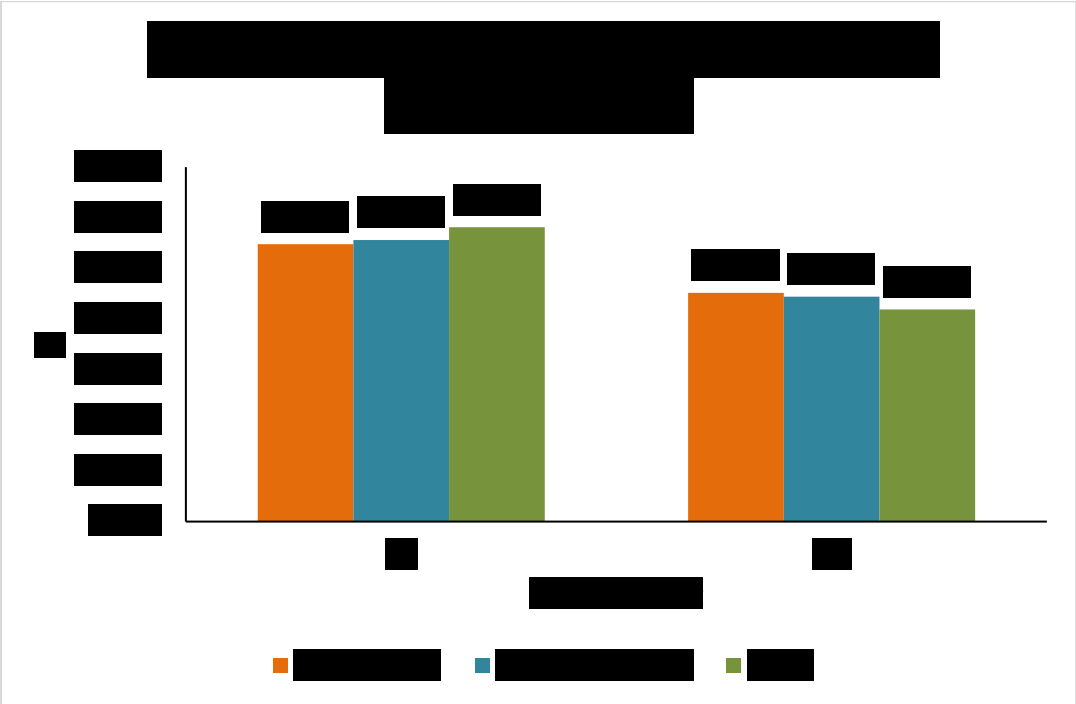
[redacted]

Although the variations are not substantial, the findings highlight that both lower and marginally better socioeconomic groups are significantly burdened with oral complications, reinforcing the need for affordable dental services, preventive programs, and oral health education targeting economically disadvantaged diabetic populations.

Table 8: Oral manifestations Distribution according to Overcrowding

Overcrowding	Periodontitis (n)	%	Gingival Bleeding (n)	%	DMFS (n)	%
No	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Yes	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Graph 8: Oral manifestations Distribution according to Overcrowding



[redacted]

[redacted]

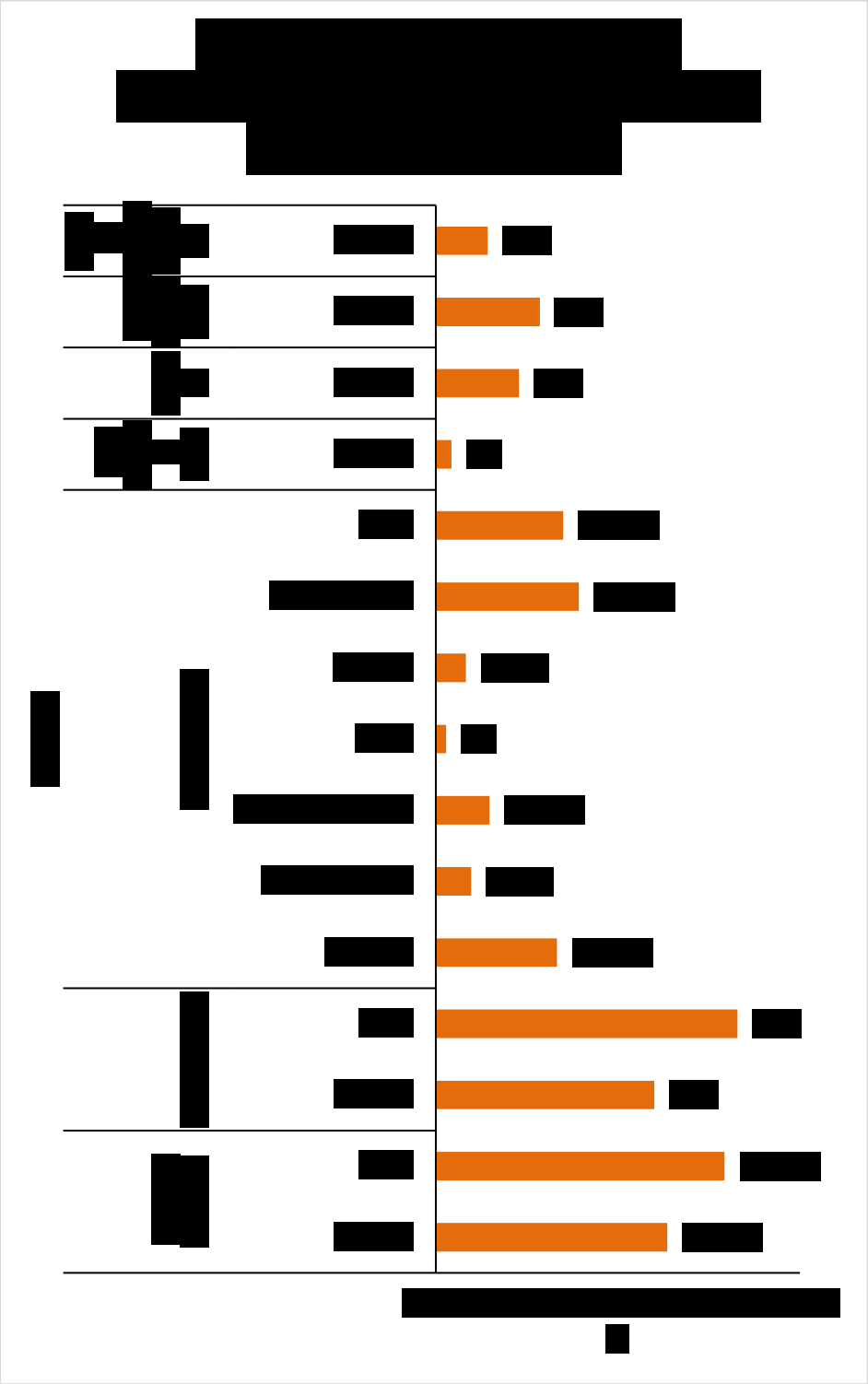
Overall, overcrowding did not show a major differentiating impact on oral health conditions in this study population, suggesting that diabetes-related oral disease burden is widespread across varying housing conditions.

Section II: Oral manifestations

Table 9: Distribution of subjects according to different variables of oral manifestation

Variable	Subcategory	n	%
Gingival Bleeding	Present	[redacted]	[redacted]
	None	[redacted]	[redacted]
Periodontitis	Present	[redacted]	[redacted]
	None	[redacted]	[redacted]
DMFS – tooth	Decayed	[redacted]	[redacted]
	Decayed, filled	[redacted]	[redacted]
	Decayed, missing	[redacted]	[redacted]
	Filled	[redacted]	[redacted]
	Missing	[redacted]	[redacted]
	Missing, filled	[redacted]	[redacted]
	None	[redacted]	[redacted]
Oral mucosal ulcer	Present	[redacted]	[redacted]
Halitosis	Present	[redacted]	[redacted]
Taste impairment	Present	[redacted]	[redacted]
Burning mouth sensation	Present	[redacted]	[redacted]

Graph 9: Distribution of subjects according to different variables of oral manifestation



[redacted]

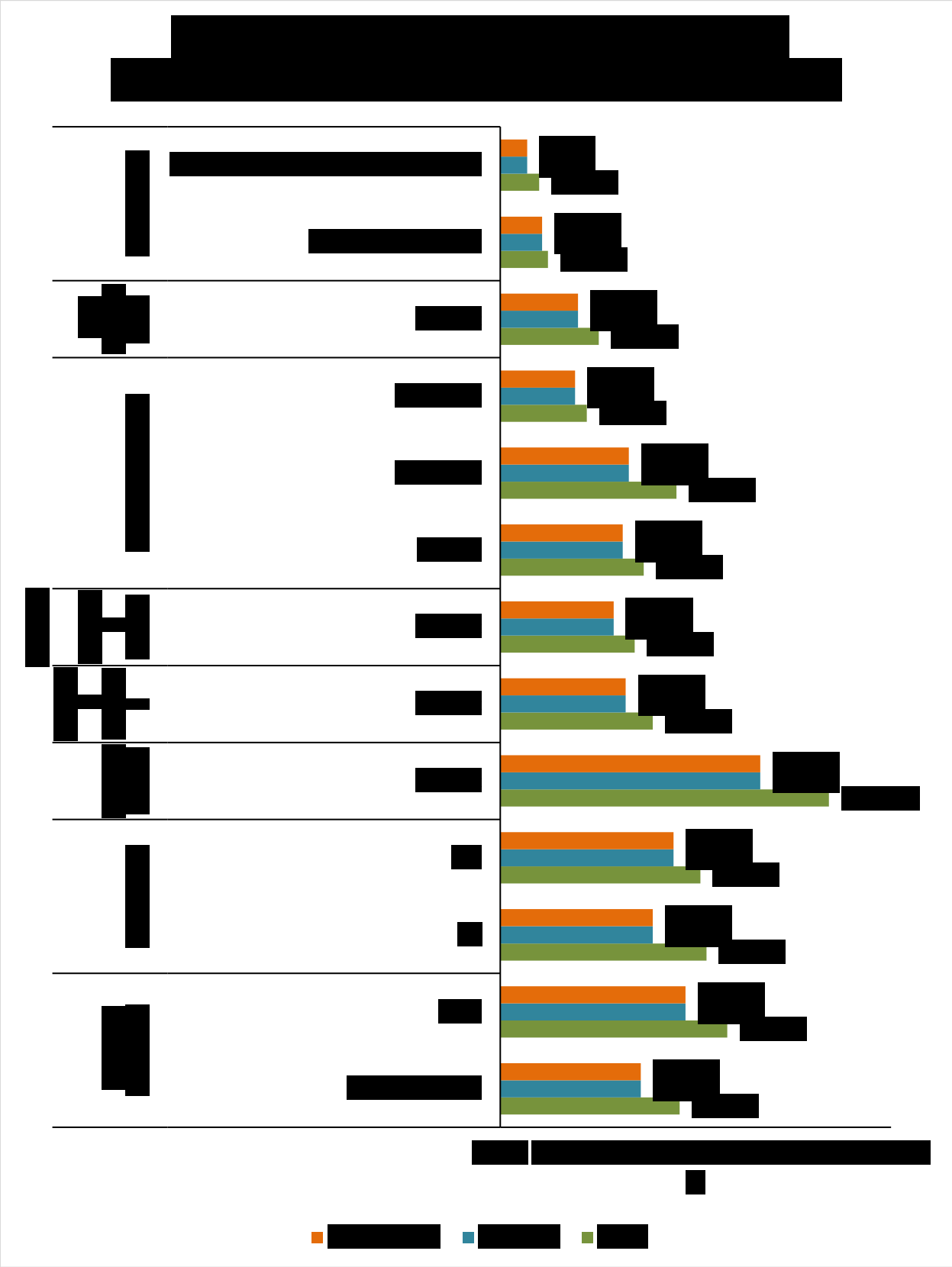
[redacted]

Early screening and multidisciplinary management strategies are therefore essential to prevent oral complications, improve glycemic outcomes, and enhance overall quality of life in diabetic individuals.

Table 10: Distribution of subjects according to different variables over oral manifestations

Variable	Value	Periodontitis (n)	%	Gingivitis (n)	%	DMFS (n)	%
Brushing Frequency	More than once	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Once	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Mouthwash	No	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Yes	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Excessive Thirst	Present	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Excessive Urination	Present	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Excessive Hunger	Present	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Diabetes Duration	5–9 yrs	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	10–14 yrs	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	15–19 yrs	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
H/O Hypertension	Present	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Past History	Family h/o diabetes	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Family h/o diabetes & hypertension	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Graph 10: Distribution of subjects according to different variables over oral manifestations



These results reinforce the need for rigorous diabetes management and improved oral hygiene behaviors to prevent disease progression.

Table 11: Association between Variables and Oral Manifestation

Variable	Subcategory	Positive (n) (%)	Negative (n) (%)	p-value
Smoking	Yes	[redacted]	[redacted]	[redacted]
	No	[redacted]	[redacted]	
Alcohol	Yes	[redacted]	[redacted]	[redacted]
	No	[redacted]	[redacted]	
Betel quid/lime/Betelnut/Tobacco/Pan masala chewing	Yes	[redacted]	[redacted]	[redacted]
	No	[redacted]	[redacted]	
Diet	Veg	[redacted]	[redacted]	[redacted]
	Non-veg	[redacted]	[redacted]	
Diabetes Medication	Insulin	[redacted]	[redacted]	[redacted]
	Other	[redacted]	[redacted]	

[redacted]

[redacted]

[redacted]

[redacted]

These findings underline the need for habit-cessation counseling, especially in high-risk patients, as part of an integrated diabetes-oral health care strategy.

Table 12: Association between Variables and Periodontitis

Table 12a: Socio-Demographic Variables

Variable	Subcategory	Periodontitis (n)	%	p-value
Gender	Female	[redacted]	[redacted]	[redacted]
	Male	[redacted]	[redacted]	
Religion	Hindu	[redacted]	[redacted]	[redacted]
	Muslim	[redacted]	[redacted]	
Education	Graduation	[redacted]	[redacted]	[redacted]
	High School, PUC or Diploma	[redacted]	[redacted]	
	Illiterate	[redacted]	[redacted]	
	Primary	[redacted]	[redacted]	
Family type	Joint	[redacted]	[redacted]	[redacted]
	Nuclear	[redacted]	[redacted]	
Socio-economic status	IV	[redacted]	[redacted]	[redacted]
	V	[redacted]	[redacted]	
BPL card holder	Yes	[redacted]	[redacted]	[redacted]
	NA	[redacted]	[redacted]	
Overcrowding	No	[redacted]	[redacted]	[redacted]
	Yes	[redacted]	[redacted]	

[redacted]

[redacted]

[redacted]Overall, periodontitis was prevalent across all socio-demographic groups, with religion emerging as the only factor significantly associated with its occurrence in this study.

Table 12b: Clinical Symptoms

Variable	Subcategory	Periodontitis (n)	%	p-value
Taste impairment	Present	[redacted]	[redacted]	[redacted]
Burning mouth sensation	Present	[redacted]	[redacted]	[redacted]
Brushing frequency	More than once	[redacted]	[redacted]	[redacted]
	Once	[redacted]	[redacted]	
Mouthwash use	No	[redacted]	[redacted]	[redacted]
	Yes	[redacted]	[redacted]	
Excessive thirst	Present	[redacted]	[redacted]	[redacted]
Excessive urination	Present	[redacted]	[redacted]	[redacted]
Excessive hunger	Present	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

[redacted]Overall, these findings highlight poor glycemic control as the key clinical factor associated with periodontitis, while oral hygiene practices and other diabetic symptoms showed no statistically significant association in this study.

Table 12c: Systemic - Related Variables

Variable	Subcategory	Periodontitis (n)	%	p-value
Diabetes duration	5–9 years	[redacted]	[redacted]	[redacted]
	10–14 years	[redacted]	[redacted]	
	15–19 years	[redacted]	[redacted]	
History of Hypertension (H/O HTN)	Present	[redacted]	[redacted]	[redacted]
Family history of diabetes	Present	[redacted]	[redacted]	[redacted]
Family history of diabetes & hypertension	Present	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

[redacted]

Overall, these findings indicate that personal metabolic control and current clinical status may have a greater impact on periodontal health than disease duration, hypertension, or family history in type 2 diabetes mellitus patients.

Table 13: Association between Variables and Gingival Bleeding

Table 13a: Socio-Demographic Variables

Variable	Subcategory	Gingival Bleeding (n)	%	p-value
Gender	Female	[redacted]	[redacted]	[redacted]
	Male	[redacted]	[redacted]	[redacted]
Religion	Hindu	[redacted]	[redacted]	[redacted]
	Muslim	[redacted]	[redacted]	[redacted]
Education	Graduation	[redacted]	[redacted]	[redacted]
	High School / PUC / Diploma	[redacted]	[redacted]	[redacted]
	Illiterate	[redacted]	[redacted]	[redacted]
	Primary	[redacted]	[redacted]	[redacted]
Family type	Joint	[redacted]	[redacted]	[redacted]
	Nuclear	[redacted]	[redacted]	[redacted]
Socio-economic status	Class IV	[redacted]	[redacted]	[redacted]
	Class V	[redacted]	[redacted]	[redacted]
BPL card holder	Yes	[redacted]	[redacted]	[redacted]
	NA / No	[redacted]	[redacted]	[redacted]
Overcrowding	No	[redacted]	[redacted]	[redacted]
	Yes	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

Overall, gingival bleeding was widely prevalent across different socio-demographic groups, with religion emerging as the only factor significantly associated in this study population.

Table 13b: Clinical Symptoms

Variable	Subcategory	Gingival Bleeding (n)	%	p-value
Taste impairment	Present	[redacted]	[redacted]	[redacted]
Burning mouth sensation	Present	[redacted]	[redacted]	[redacted]
Brushing frequency	More than once	[redacted]	[redacted]	[redacted]
	Once	[redacted]	[redacted]	
Mouthwash use	No	[redacted]	[redacted]	[redacted]
	Yes	[redacted]	[redacted]	
Excessive thirst	Present	[redacted]	[redacted]	[redacted]
Excessive urination	Present	[redacted]	[redacted]	[redacted]
Excessive hunger	Present	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

[redacted]

Overall, these results highlight that diabetes-related symptoms, particularly excessive thirst and burning mouth sensation, are key contributors to gingival bleeding, whereas routine oral hygiene practices alone did not show a significant independent association in this study.

Table 13c: Systemic - Related Variables

Variable	Subcategory	Gingival Bleeding (n)	%	p-value
Diabetes duration	5–9 years	[redacted]	[redacted]	[redacted]
	10–14 years			
	15–19 years			
H/O Hypertension	Present			
Family h/o diabetes	Present			
Family h/o diabetes & hypertension	Present			

[redacted]

[redacted]

[redacted]

Overall, these findings suggest that gingival bleeding is not significantly influenced by disease duration, hypertension, or family medical history, and may be more closely related to current metabolic control and local oral factors in patients with type 2 diabetes mellitus.

Table 14: Association between Variables and DMFS

Table 14a: Socio-Demographic Variables

Variable	Subcategory	DMFS (n)	%	p-value
Gender	Female	[redacted]	[redacted]	[redacted]
	Male	[redacted]	[redacted]	
Religion	Hindu	[redacted]	[redacted]	[redacted]
	Muslim	[redacted]	[redacted]	
Education	Graduation	[redacted]	[redacted]	[redacted]
	High School, PUC or Diploma	[redacted]	[redacted]	
	Illiterate	[redacted]	[redacted]	
	Primary	[redacted]	[redacted]	
Family type	Joint	[redacted]	[redacted]	[redacted]
	Nuclear	[redacted]	[redacted]	
Socio-economic status	IV	[redacted]	[redacted]	[redacted]
	V	[redacted]	[redacted]	
BPL card holder	Yes	[redacted]	[redacted]	[redacted]
	NA	[redacted]	[redacted]	
Overcrowding	No	[redacted]	[redacted]	[redacted]
	Yes	[redacted]	[redacted]	

[redacted]

[redacted]

[redacted]

Overall, DMFS was prevalent across all socio-demographic groups, with religion emerging as the only variable significantly associated in this study population.

Table 14b: Clinical Symptoms

Variable	Subcategory	DMFS (n)	%	p-value
Taste impairment	Present	[redacted]	[redacted]	[redacted]
Burning mouth sensation	Present	[redacted]	[redacted]	[redacted]
Brushing Frequency	More than once	[redacted]	[redacted]	[redacted]
	once	[redacted]	[redacted]	
Mouthwash	No	[redacted]	[redacted]	[redacted]
	Yes	[redacted]	[redacted]	
Excessive thirst	Present	[redacted]	[redacted]	[redacted]
Excessive urination	Present	[redacted]	[redacted]	[redacted]
Excessive hunger	Present	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

[redacted]

Overall, these findings suggest that DMFS in diabetic patients is widely prevalent and influenced by multiple factors, with no single clinical or behavioral variable showing an independent statistically significant association in this study population.

Table 14c: Systemic - Related Variables

Variable	Subcategory	DMFS (n)	%	p-value
Diabetes Duration	5-9 yrs	[redacted]	[redacted]	[redacted]
	10-14 yrs			
	15-19 yrs			
H/O Hypertension	Present			[redacted]
Family h/o diabetes	Present			
Family h/o diabetes and hypertension	Present	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

Overall, these findings indicate that DMFS is not significantly influenced by diabetes duration, hypertension, or family history alone, and that cumulative dental caries experience in type 2 diabetes mellitus patients is likely multifactorial, depending on long-term glycemic control, oral hygiene practices, and access to dental care rather than isolated historical factors.

Table 15: Mann-Whitney U test, Comparing the duration of diabetes and oral manifestation

Oral Manifestations	n	%	Mann-Whitney U statistic	p-value
Present	[redacted]	[redacted]	[redacted]	[redacted]
Absent	[redacted]	[redacted]		

[redacted] Therefore, early diagnosis and strict glycemic control, supported by regular dental check-ups, are essential to minimize the cumulative oral health burden in diabetic individuals.

DISCUSSION

DISCUSSION

Distribution of subjects according to demographic details

In the present cross-sectional study conducted among 400 type 2 diabetes mellitus patients residing in urban Belagavi, the mean age of [redacted] years highlights that diabetes predominantly affects middle-aged and early elderly adults. This age distribution is consistent with global and Indian epidemiological patterns, where the burden of type 2 diabetes increases significantly after the fourth decade of life, largely due to cumulative metabolic risk exposure and lifestyle changes (Kushner et al.[redacted]Similar age profiles have been reported in Indian oral health studies among diabetic populations, including those from Mysuru and North Karnataka, where mean ages ranged between 50 and 56 years (Nimbal et al.[redacted] BR P et al.[redacted]

[redacted]This demographic pattern is clinically important because lower educational attainment has been repeatedly associated with poor diabetes self-management, limited oral health awareness, and delayed dental care utilization (Nazir et al.[redacted]Studies evaluating oral complications of diabetes consistently emphasize that low literacy amplifies the severity and chronicity of periodontal disease and caries due to inadequate preventive behaviors (Verhulst et al.[redacted]

[redacted]Similar socio-economic clustering has been reported in Indian community-based diabetic cohorts (BR P et al.[redacted]

Overall, the demographic profile of the present study represents a vulnerable population in whom diabetes-related oral complications are likely to be under-recognized and under-treated,

reinforcing the need for integrated oral health screening within diabetes care programs.

Oral manifestations distribution by gender

In the present study, males demonstrated a slightly higher proportion of periodontitis [redacted] and gingival bleeding [redacted] whereas females showed marginally higher DMFS involvement [redacted] From a biological perspective, diabetes-related immune dysregulation and heightened inflammatory response affect both sexes similarly; however, behavioral modifiers often amplify periodontal damage in men (Zhao et al[redacted]; Ranbhise et al.[redacted]

Therefore, the findings of the present study support existing literature suggesting subtle gender-based differences in oral disease patterns but reinforce that preventive and therapeutic oral health strategies must target both males and females equally within diabetic care frameworks.

Oral manifestations distribution by religion

The present study demonstrated a higher proportion of periodontitis, gingival bleeding, and DMFS among Hindu participants compared to Muslims. [redacted]

[redacted]

Similar patterns have been observed in Indian community-based studies where disease distribution mirrors population composition rather than indicating religion-specific biological susceptibility ([redacted]Instead, differences are more plausibly explained by variations in socio-economic conditions, dietary habits, oral hygiene practices, and healthcare utilization patterns across communities ([redacted], [redacted]

Furthermore, dietary patterns traditionally rich in refined carbohydrates, frequency of snacking, and limited preventive dental visits have been implicated in higher DMFS scores in several Indian studies [redacted]From a public health perspective, oral health interventions should be community-inclusive, with intensity guided by disease burden rather than religious categorization.

Oral manifestations distribution by education

In the present study, educational status showed a clear descriptive gradient in oral disease burden. [redacted]

From a mechanistic perspective, diabetes promotes periodontal tissue destruction through immune dysregulation, inflammatory pathway activation, and impaired healing, but the clinical expression of these mechanisms worsens when plaque control is poor and periodontal disease remains These findings support targeted education-based interventions: simplified oral health messaging, structured oral hygiene demonstrations, and integration of dental screening into routine diabetic care for low-literacy populations.

Oral manifestations distribution by family type

The present study showed a modestly higher proportion of periodontitis, gingival bleeding, and DMFS among individuals living in nuclear families compared to those in joint families.

In Indian diabetic cohorts, high periodontal burden and DMFS accumulation have been consistently linked to delayed dental consultations and low preventive orientation

Biologically, the central driver remains diabetes-induced inflammation, altered immunity, and impaired tissue healing, which predispose to periodontal breakdown and caries progression irrespective of family structure

At the same time, joint-family settings should not be assumed protective, as the overall burden remains high across both groups.

Oral manifestations distribution by occupation

Occupation in the present study showed that housewives contributed the largest share of periodontitis, gingival bleeding, and DMFS, followed by daily wage workers.

Studies assessing systemic–oral links in diabetes emphasize that salivary dysfunction, xerostomia, and oral microbial changes increase susceptibility to caries and periodontal disease, and these effects become clinically worse when preventive care is limited (; Verhulst et al. Mechanistically, diabetes-related immune-inflammatory dysregulation promotes periodontal breakdown and impaired healing, and plaque control and timely periodontal care are key modifiers (Ranbhise et al. The programmatic implication is to integrate low-cost oral screening and counselling into diabetes care, with flexible delivery approaches (health camps, clinic-based screening, brief counselling modules) that specifically accommodate the constraints faced by housewives and daily wage workers.

Oral manifestations distribution by socio-economic status

In the present study, oral manifestations were widely prevalent across both lower socio-economic classes (Class IV and Class V), with only marginal differences observed between the two groups.

Comparatively, multiple reviews and cross-sectional studies have emphasized that diabetes-related oral complications are significantly more common in economically weaker populations due to reduced access to preventive dental care, delayed treatment seeking, and lower affordability of restorative services (; Verhulst et al.

These results highlight the need for affordable, preventive, and community-based dental services integrated into diabetes care programs for economically disadvantaged populations.

Oral manifestations distribution by overcrowding

The present study showed that participants not residing in overcrowded households contributed a higher proportion of periodontitis, gingival bleeding, and DMFS compared to those living in overcrowded conditions.

Indian studies evaluating oral health in diabetic populations have reported that tooth loss is more common among individuals from disadvantaged living conditions, which can mask the true lifetime burden of periodontal disease (Nimbal et al; BR P et al.

From a biological standpoint, diabetes-related mechanisms—such as immune dysfunction, chronic inflammation, and salivary alterations—operate irrespective of housing conditions (Păunică et al. 2023; Zhao et al.

Universal oral screening for diabetic patients is therefore essential, irrespective of household density.

Overall prevalence of oral manifestations

Substantial burden of oral manifestations among type 2 diabetes mellitus patients in the present study.

The bidirectional relationship between diabetes and periodontal disease is well established, with chronic hyperglycemia promoting periodontal inflammation and periodontal infection worsening glycemic control (Păunică et al. ; Ranbhise et al.

The high DMFS burden observed in our study reflects cumulative exposure to xerostomia, altered salivary composition, increased salivary glucose levels, and microbial dysbiosis in diabetes (

The finding that nearly four-fifths of participants exhibited at least one oral manifestation underscores the necessity of integrating routine oral examinations into diabetes management protocols to reduce morbidity and improve overall quality of life.

Distribution of subjects according to different variables over oral manifestations

Behavioral factors, diabetic symptoms, disease duration, and medical history in relation to periodontitis, gingivitis, and DMFS.

Dental plaque accumulation is the primary etiological factor for gingivitis and periodontitis, and in diabetic individuals, impaired host response amplifies the destructive effects of plaque-induced inflammation (

Comparative studies emphasize that diabetes modifies the periodontal response to plaque through chronic inflammation, neutrophil dysfunction, and advanced glycation end products, making even modest lapses in oral hygiene clinically significant (

Overall, Table 10 underscores that poor oral hygiene practices, poor glycemic control, and longer disease duration act synergistically to increase oral disease burden in diabetic patients, reinforcing the need for early preventive interventions and metabolic control.

Association between lifestyle variables and presence of oral manifestations

Association of lifestyle habits and diabetes medication with the presence of oral manifestations.

Overall, Table 11 highlights that tobacco-related chewing habits are a major modifiable risk factor for oral disease in diabetic patients, and cessation counseling should be an integral part of diabetes

and oral health management.

Association between variables and periodontitis

Socio-demographic, clinical, and history-related variables associated with periodontitis. [redacted]

In summary, Table 12 confirms that poor glycemic control, reflected by excessive thirst, is the strongest clinical determinant of periodontitis in this diabetic population, reinforcing the need for integrated metabolic and periodontal care.

Association between variables and gingival bleeding

Socio-demographic, clinical, and history-related variables associated with gingival bleeding among type 2 diabetes mellitus patients. [redacted] Gingival inflammation is primarily plaque-induced, and diabetes amplifies this response through impaired immune regulation and increased inflammatory mediator release ([redacted] Burning mouth sensation has been linked to diabetic neuropathy, mucosal atrophy, and salivary dysfunction (Granot and Nagler, 2005; Bookout et al.[redacted] Excessive thirst, a marker of poor glycemic control, reflects underlying xerostomia and salivary composition changes, which reduce plaque clearance and antimicrobial activity ([redacted] Mata et al.[redacted] This aligns with evidence that while oral hygiene behavior is important, diabetes-related metabolic dysregulation can override routine hygiene effects when glycemic control is poor (Păunică et al.[redacted]

Overall, Table 13 reinforces that gingival bleeding in diabetic patients is predominantly driven by

poor glycemic control and salivary-neuropathic alterations rather than demographic or historical factors, emphasizing the importance of metabolic optimization and early periodontal care.

Association between variables and DMFS

Association of socio-demographic, clinical, and history-related variables with DMFS, a cumulative indicator of dental caries experience. [redacted] Reduced salivary flow and increased salivary glucose promote cariogenic bacterial growth and enamel demineralization ([redacted]

In summary, Table 14 demonstrates that DMFS in diabetic patients is a multifactorial outcome primarily driven by long-standing metabolic disturbances and salivary dysfunction, with oral

hygiene practices modulating but not independently determining disease severity.

Association between duration of diabetes and presence of oral manifestations

Mann-Whitney U test comparing diabetes duration with the presence of oral manifestations. [redacted] Longer exposure to hyperglycemia leads to sustained immune dysregulation, microvascular damage, and chronic inflammation, which together compromise periodontal tissues, salivary glands, and oral mucosa [redacted] Advanced glycation end products accumulate over time, impair collagen turnover, and intensify inflammatory responses, accelerating periodontal destruction and delaying tissue repair (Zhang et [redacted]

Salivary gland dysfunction also worsens with prolonged diabetes, leading to persistent xerostomia, altered antimicrobial defense, and increased susceptibility to caries and mucosal infections ([redacted] Integrating dental evaluation into long-term diabetes management is essential to improve overall quality of life.

STRENGTHS AND LIMITATIONS

STRENGTHS OF THE STUDY

Community-based urban setting.

5. The study provides valuable local evidence from urban Belagavi, Karnataka, addressing a gap in community-level data on oral manifestations in type 2 diabetes mellitus.

LIMITATIONS OF THE STUDY

[redacted] Lack of objective glycemic control measures. [redacted]

4. [redacted] Factors such as dietary sugar intake frequency, frequency of dental visits, and use of adjunctive oral hygiene aids were not evaluated, which may influence oral health outcomes.

CONCLUSION

CONCLUSION

The present cross-sectional study highlights a high burden of oral manifestations among patients with type 2 diabetes mellitus residing in selected urban areas of Belagavi. [redacted] Incorporating dental evaluation into routine diabetic follow-up, especially for long-standing and poorly controlled cases, can help reduce oral morbidity, improve quality of life, and potentially contribute to better overall metabolic outcomes.

SUMMARY

SUMMARY

This cross-sectional study was conducted to assess the prevalence of oral manifestations among patients with type 2 diabetes mellitus residing in selected urban areas of Belagavi, Karnataka. [redacted]

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BIBLIOGRAPHY

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ANNEXURES

ANNEXURES I

INFORMED CONSENT FORM

[redacted]

Objective: [redacted]

Introduction: [redacted].

Explanation of procedure [redacted]

Privacy and confidentiality: [redacted]

Questions: [redacted]

Legal rights: [redacted]

CONSENT STATEMENT

[redacted]

Name of the participant:

Signature or left thumb impression of the participant:

Name of the witness:

Signature or left thumb impression of the witness:

Name of the investigator:

Signature of the investigator:

ANNEXURES II

QUESTIONNAIRE

"PREVALENCE OF ORAL MANIFESTATIONS IN TYPE 2 DIABETES MELLITUS PATIENTS RESIDING IN URBAN BELAGAVI : A CROSS SECTIONAL STUDY ."

Sl. No: _____ Date of registration: _____

1. ***Name:***
2. ***Age: _____yrs.***
3. ***Sex: Male /Female***
4. ***Occupation: .....***
5. ***Religion: Hindu/ Muslim/ Christian/ Others***
6. ***Education status: Illiterate/Primary/ High school PUC or Diploma/Graduation***
7. ***Marital status: Married /unmarried/ Widow/Widower/ Divorcee***
8. ***Family: Nuclear/ Joint /Extended /Broken***
9. ***Total income of family per month: Rs. _____***
10. ***Total number of family members: _____***
11. ***Socio economic status: I / II / III / IV / V***
12. ***Whether belongs to : APL(above poverty line)/ BPL(below poverty line)***
13. ***Type of house: Kachha /Semi-pucca / Pucca***
14. ***House well ventilated : Yes / No***
15. ***Overcrowding Yes / No***

Clinical profile

Chief complaints: .....

a) Oral hygiene habits:

Brushing:

Mouthwash:

b) Examination of the oral cavity:

Loss of attachment

Severity

0 = 0–3 mm
1 = 4–5 mm Cemento-enamel junction (CEJ) within black band
2 = 6–8 mm CEJ between upper limit of black band and 8.5 mm ring
3 = 9–11 mm CEJ between 8.5 mm and 11.5 mm ring
4 = 12 mm or more CEJ beyond 11.5 mm ring
X = Excluded sextant
9 = Not recorded

* Not recorded under 15 years of age

Index teeth

	17/16	11	26/27	
(173)				(175)
(176)				(178)
	47/46	31	36/37	

Periodontal status (CPI Modified)

	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28	
Bleeding (109)																	(124)
Pocket (125)																	(140)
Bleeding (141)																	(156)
Pocket (157)																	(172)
	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38	

Gingival bleeding

Score

0 = Absence of condition
1 = Presence of condition
9 = Tooth excluded
X = Tooth not present

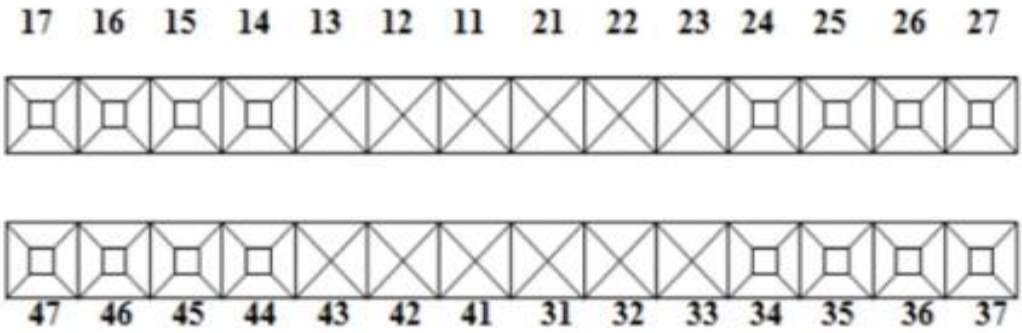
Pocket

Score

0 = Absence of condition
1 = Pocket 4–5 mm
2 = Pocket 6 mm or more
9 = Tooth excluded
X = Tooth not present

Oral mucosal lesions		Denture(s)
☐ (186) ☐ (187) ☐ (188)	☐ (189) ☐ (190) ☐ (191)	Upper ☐ (192) Lower ☐ (193)
Condition	**Location**	**Status**
0 = No abnormal condition 1 = Malignant tumour (oral cancer) 2 = Leukoplakia 3 = Lichen planus 4 = Ulceration (aphthous, herpetic, traumatic) 5 = Acute necrotizing ulcerative gingivitis (ANUG) 6 = Candidiasis 7 = Abscess 8 = Other condition (specify if possible) 9 = Not recorded	0 = Vermillion border 1 = Commissures 2 = Lips 3 = Sulci 4 = Buccal mucosa 5 = Floor of the mouth 6 = Tongue 7 = Hard and/or soft palate 8 = Alveolar ridges/gingiva 9 = Not recorded	0 = No denture 1 = Partial denture 2 = Complete denture 9 = Not recorded

RECORDING FORMAT FOR DMFS



d = decayed, m = missing, f = filled, t = teeth, s = surfaces consists of all 20 primary teeth

Intervention urgency	(194)

0 = No treatment needed
1 = Preventive or routine treatment needed
2 = Prompt treatment (including scaling) needed
3 = Immediate (urgent) treatment needed due to pain or infection of dental and/or oral origin
4 = Referred for comprehensive evaluation or medical/dental treatment (systemic condition)

c) Symptoms of diabetes:

- ***Excessive thirst: Present/ Absent***
- ***Excessive urination: Present/Absent***
- ***Tingling and Numbness of hands and feet: Present/ Absent***
- ***Delayed healing of wound: Present/ Absent***
- ***Others, specify ----------***

1) Past history:

a) Hypertension: Present/Absent Duration : Drugs:

b) Tuberculosis: Present/Absent Duration : Drugs:

c) Asthma: Present/Absent Duration : Drugs:

d) Any other :

2) Personal history:

a) Habits:

Habits	*Duration*	*Frequency/Site*	*If left, since how long*
Beedi/cigarette smoking			

Alcohol			
Betel leaf/ lime/ Betelnut/Tobacco/Pan Masala Chewing			
Others (specify)			

b) Diet history: Vegetarian / Non-Vegetarian

Morning tea/coffee			
Breakfast			
Lunch			
Evening tea/ coffee			
Dinner			

3) DM History: (Life style modifications /OHA/

Insulin/ Both OHA and Insulin)

Drugs: Dosage: Duration:

4) Family History:

H/o Diabetes: Present/Absent

H/o any Renal or Cardiovascular diseases: Present/Absent

<u>Physical Examination:</u>

I) General Physical Examination

1. ***Built and nourishment: Poor / Moderate / Fair***
2. ***Height: _____ cms Weight: _____ Kgs.***
3. ***BMI:----------***
4. ***Waist/Hip ratio: ----------***

5. ***Pallor:*** ***Present/Absent***
6. ***Icterus:*** ***Present/Absent***
7. ***Pedal oedema:*** ***Present/Absent***
8. ***Lymphadenopathy:*** ***Present/Absent***
9. ***Cyanosis:*** ***Present/Absent***
10. ***Clubbing:*** ***Present/Absent***

II) Systemic Examination:

1. ***Cardiovascular system: Normal/Abnormal; if abnormal, specify:_____***

2. ***Respiratory system: Normal/Abnormal; if abnormal, specify:_____***

3. ***Nervous system: Normal/Abnormal; if abnormal, specify:_____***

4. ***Per abdomen: Normal/Abnormal; if abnormal, specify: _____***

ANNEXURES III

MASTER CHART

Age	Sex	Occupation	Religion	Education	Family Type	Socio - Economic Status	BPL Card holder	Overcrowding	Brushing Frequency	Mouthwash	Gingival Bleeding	Periodonitis	DMFS - tooth	Excessive thirst	Excessive urination	Tingling and numbness of hand and feet	Delayed wound healing	Diabetes Duration	Others Symptoms	Past history	Smoking	Alcohol	Betel leaf/lime/Betelnut/Tobacco/Pa	Diet	Diabetes Medication	BMI	PICKLE	CVS/CNS/RS/PA	RBS	H/O Hypertension
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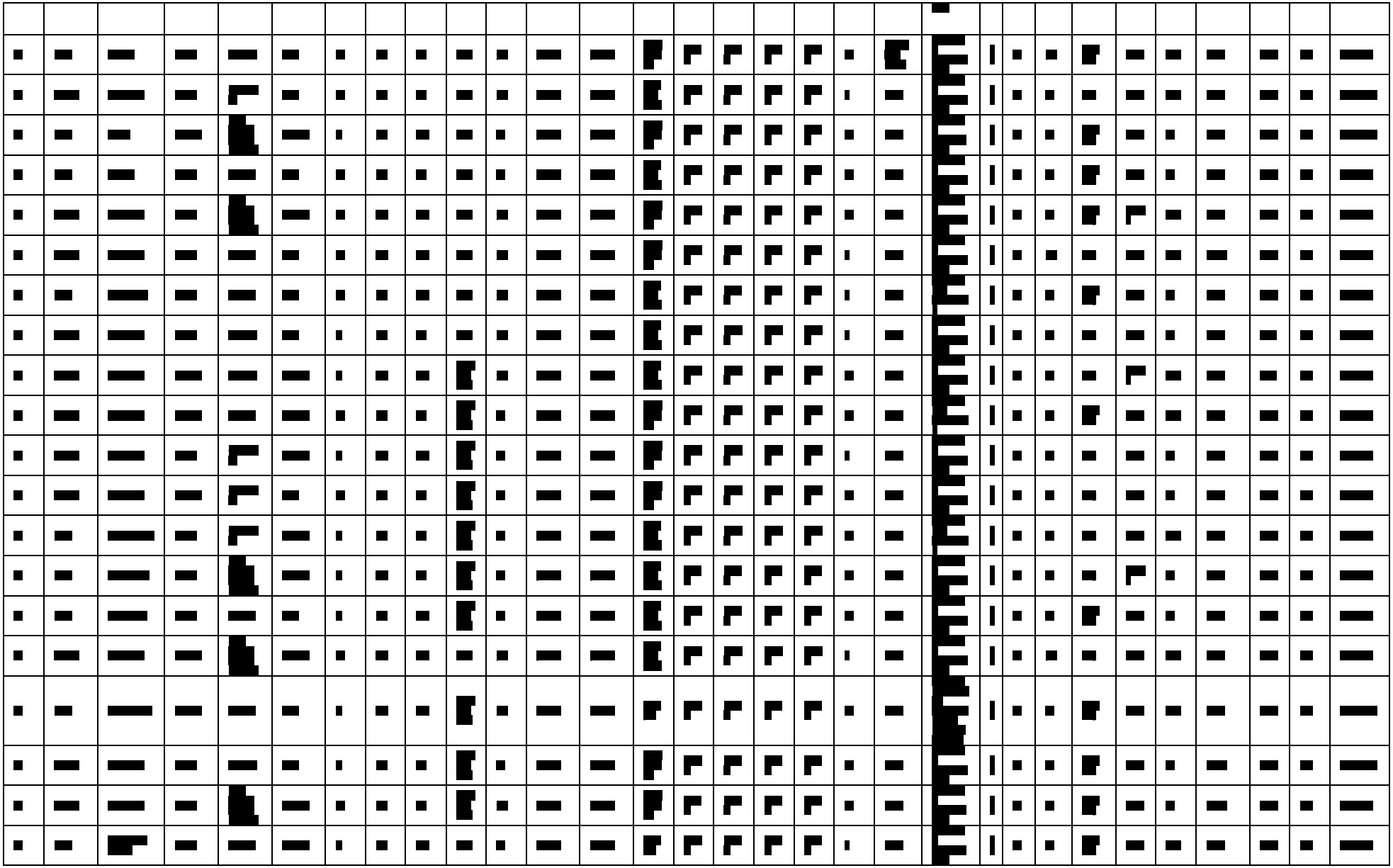

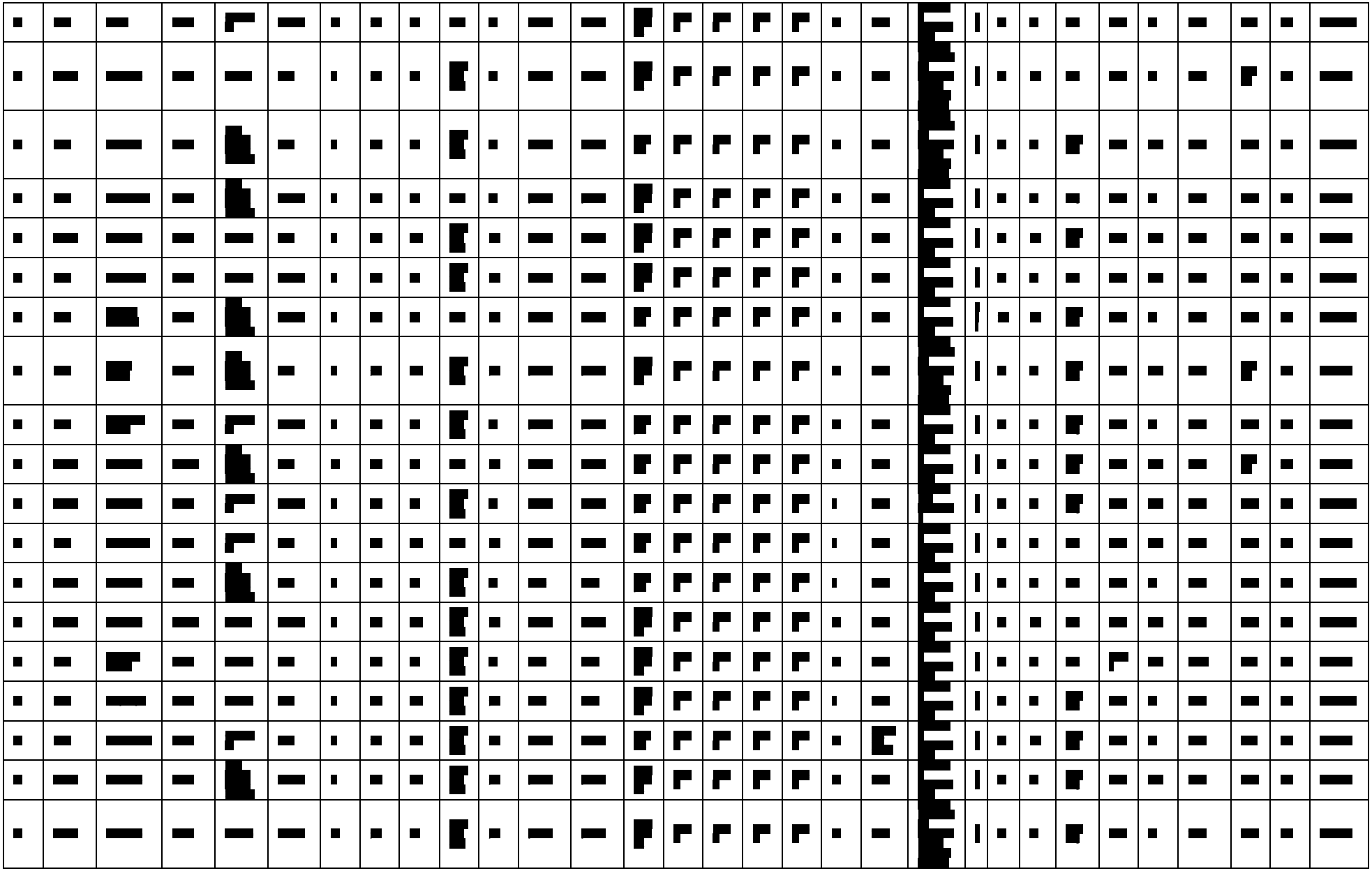

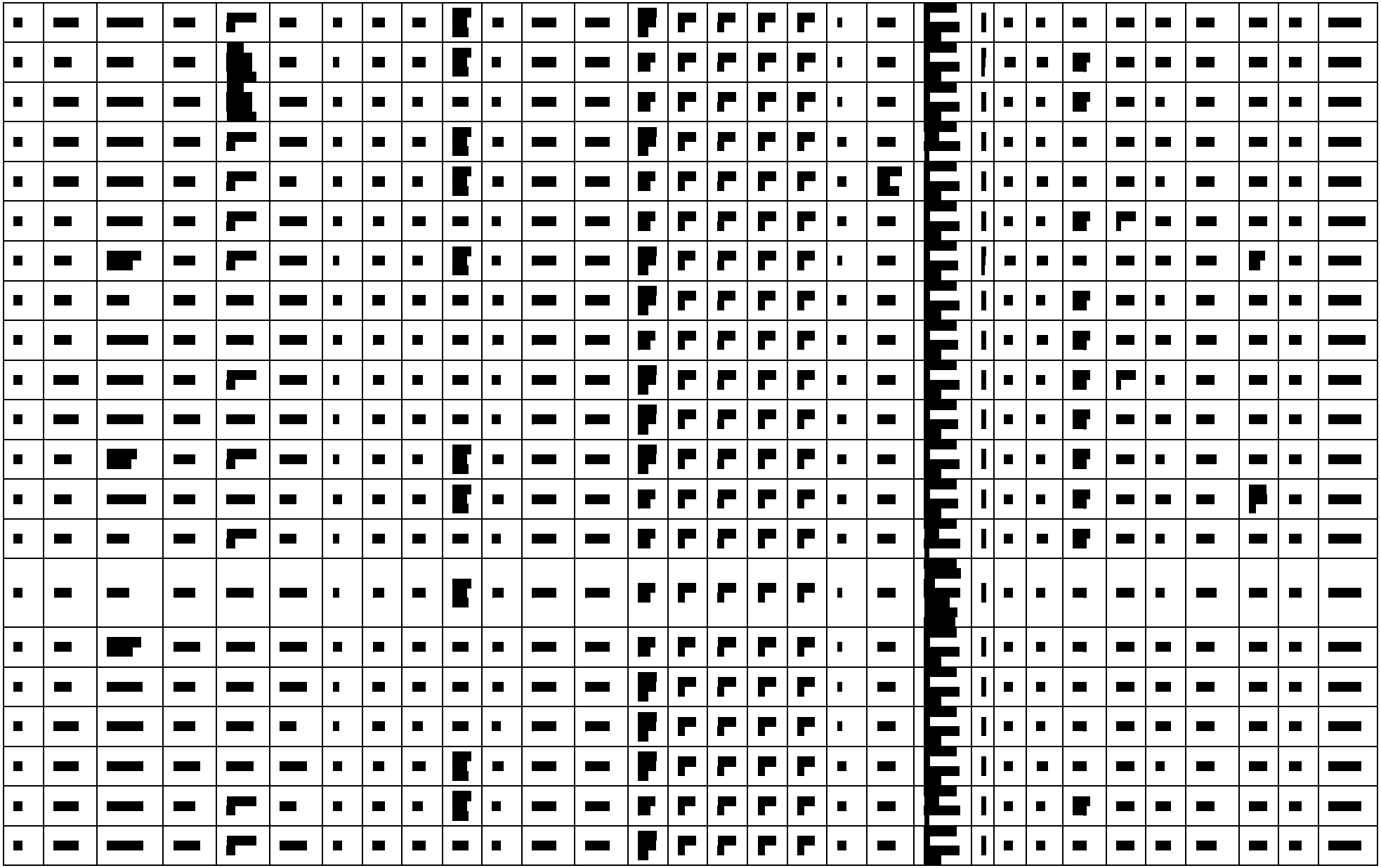

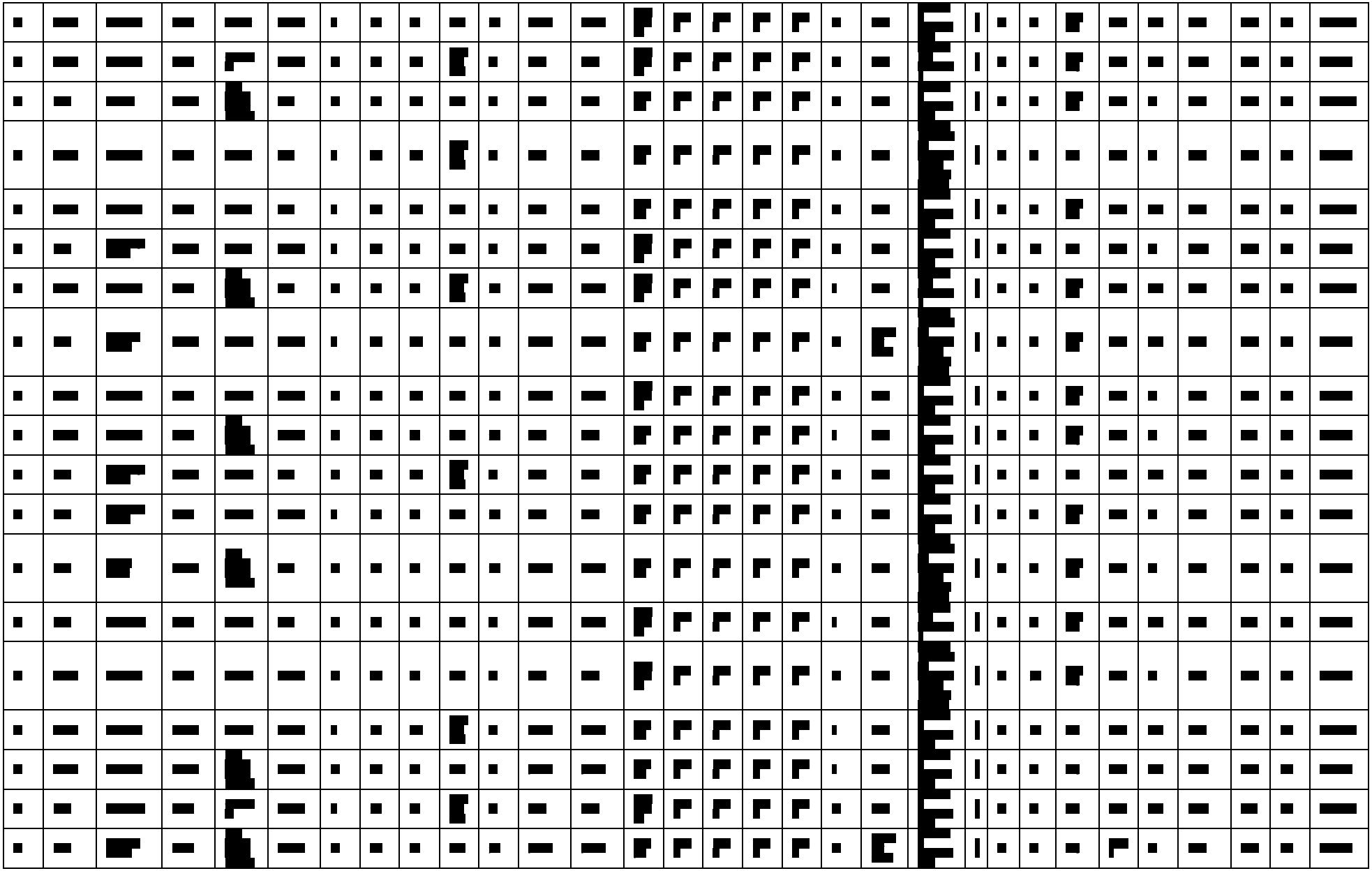

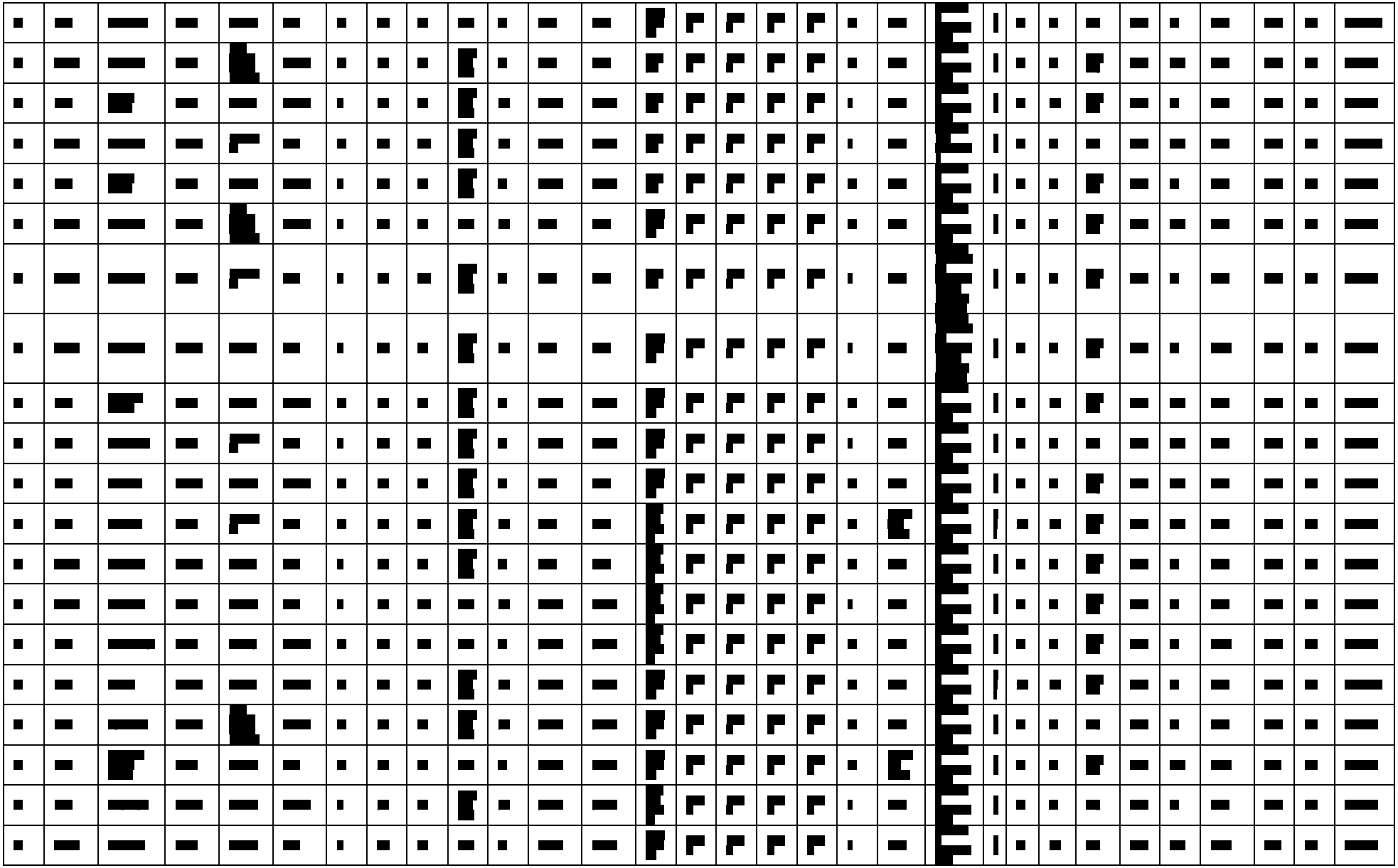

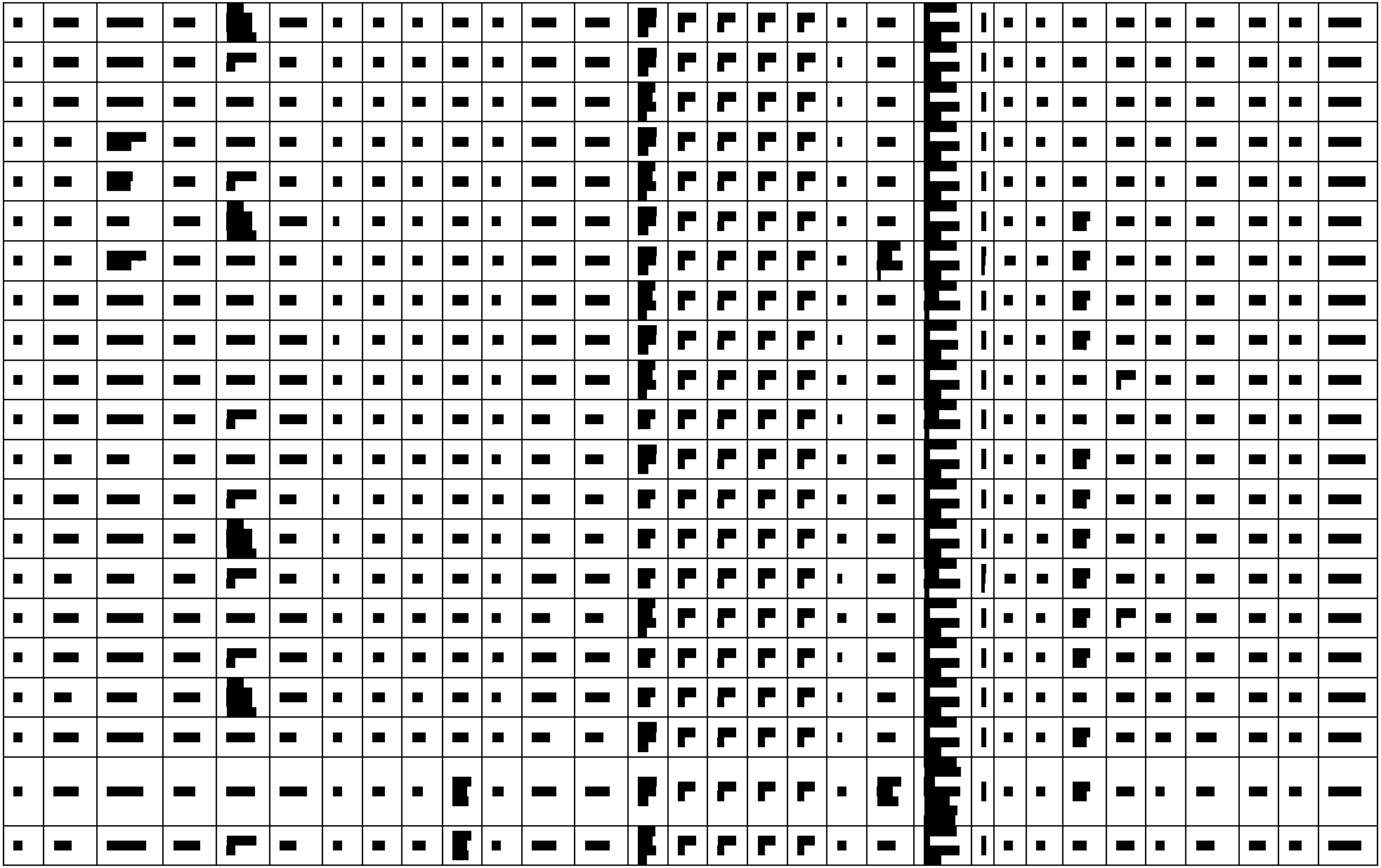

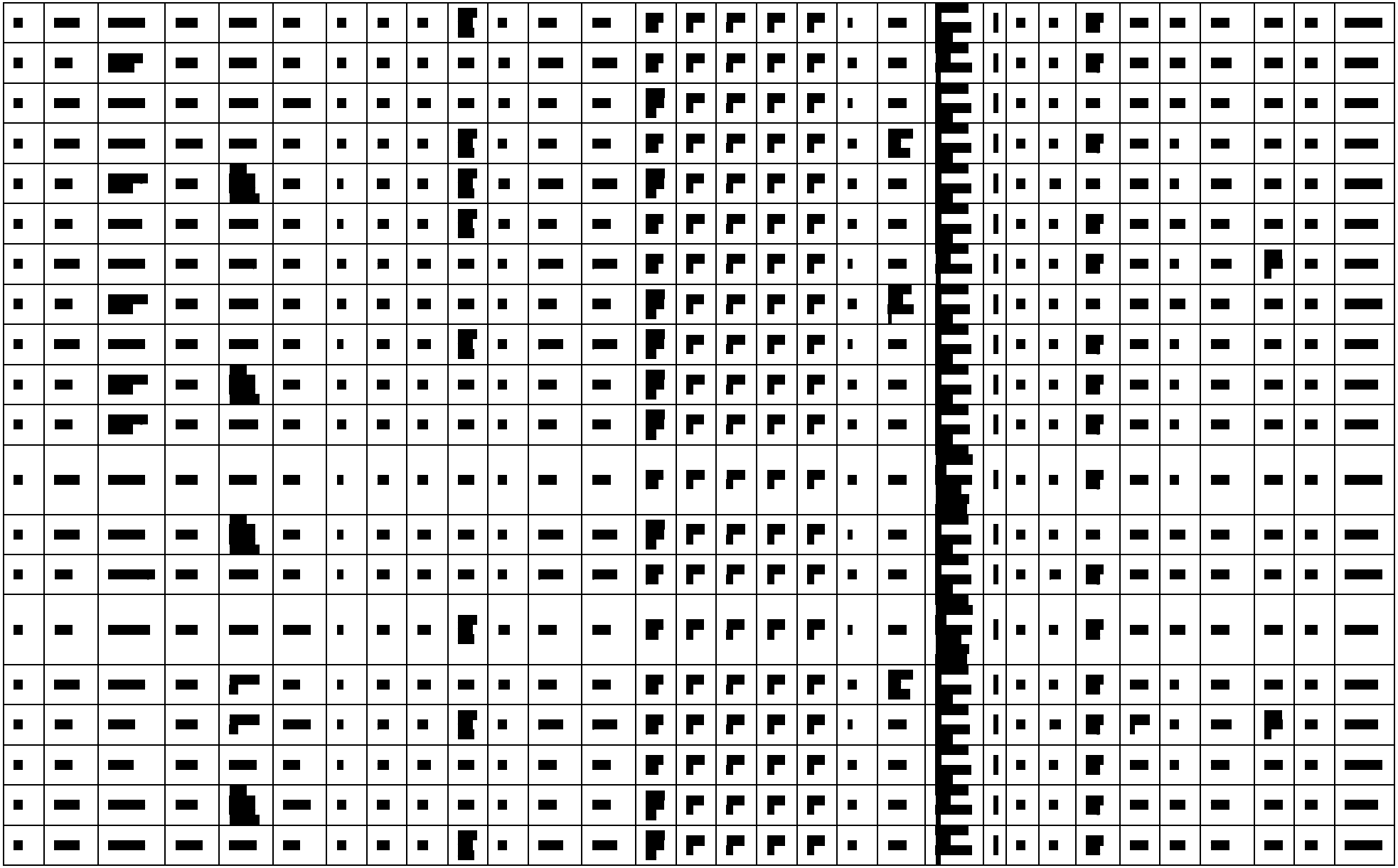

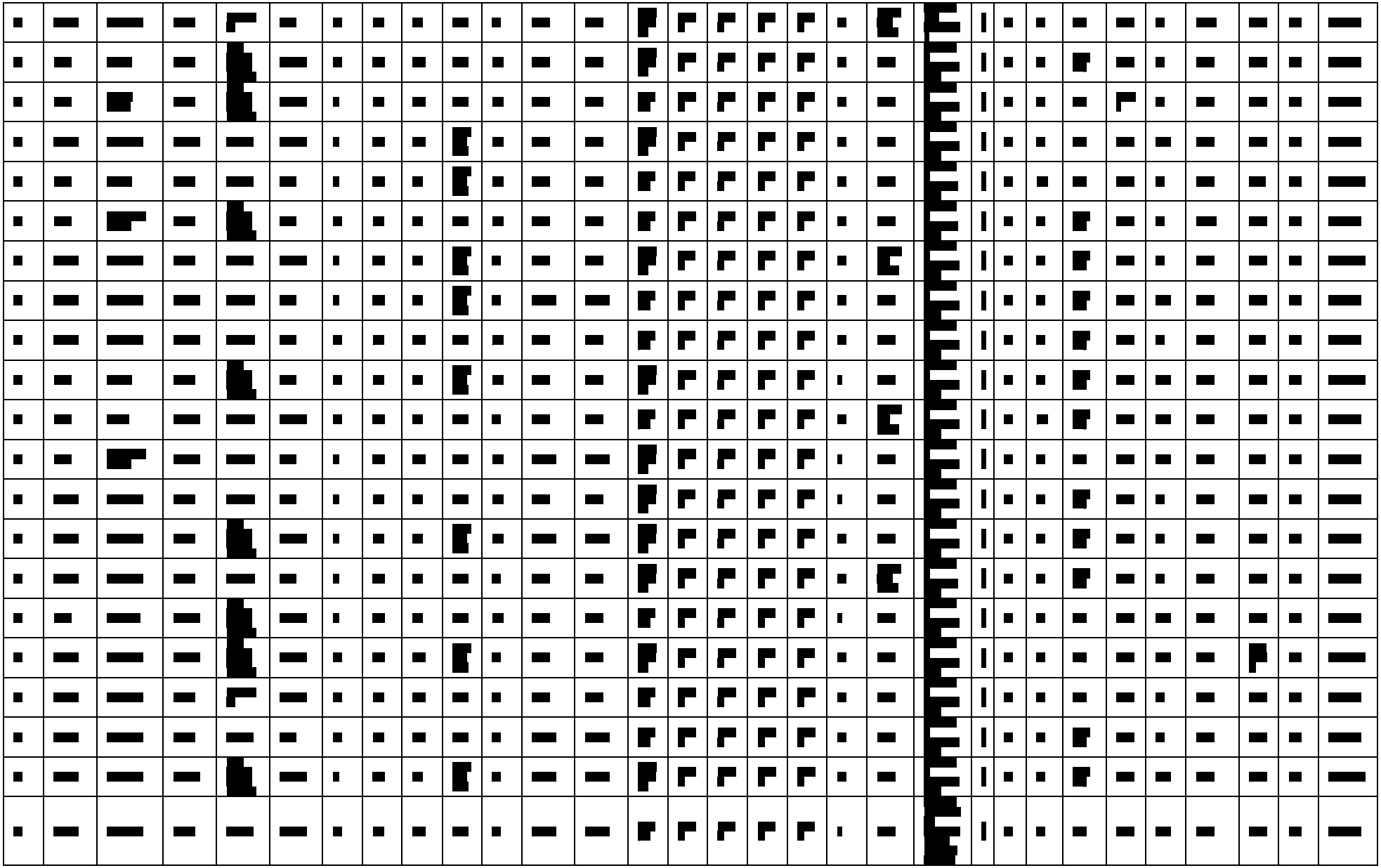

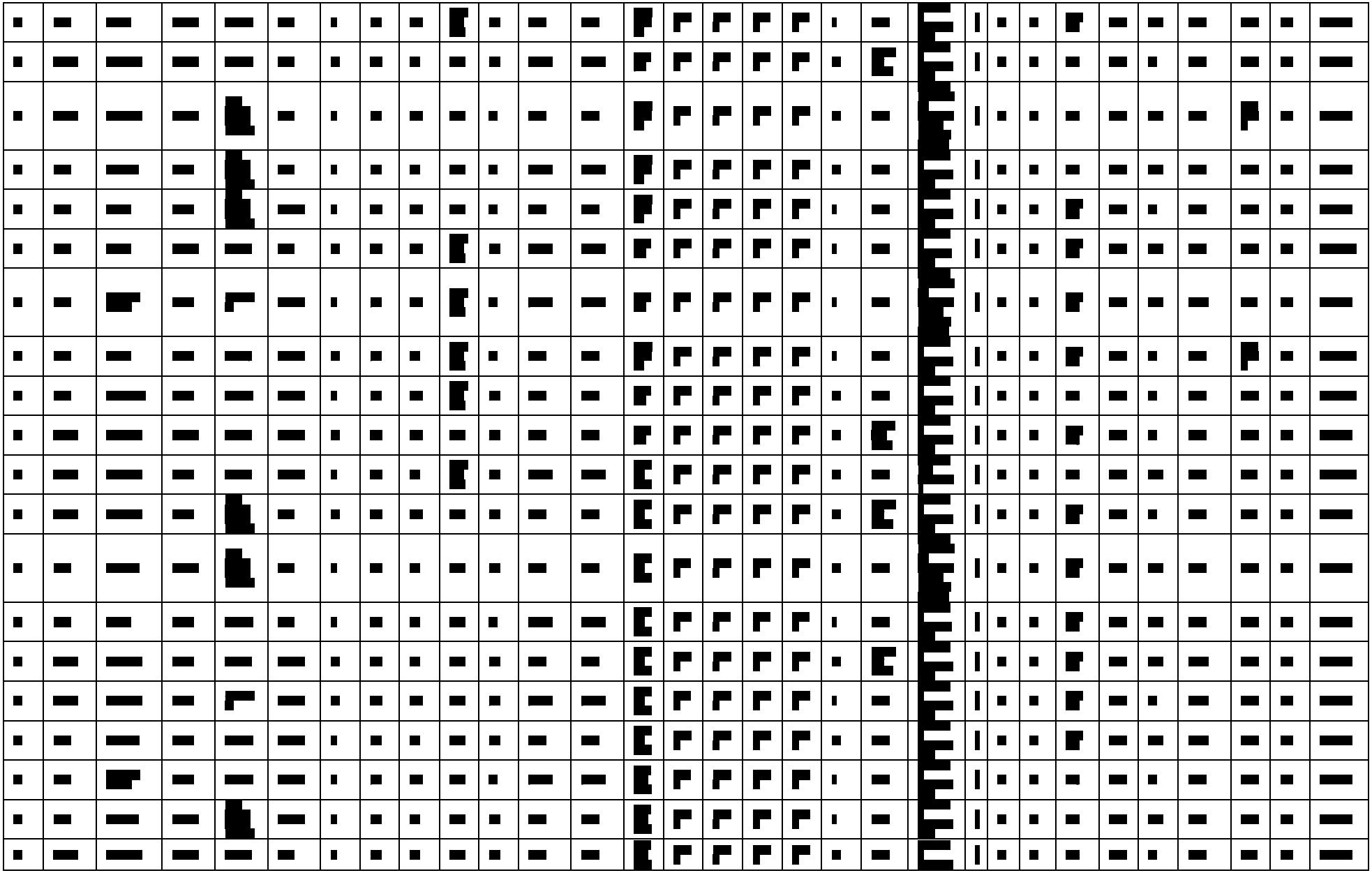

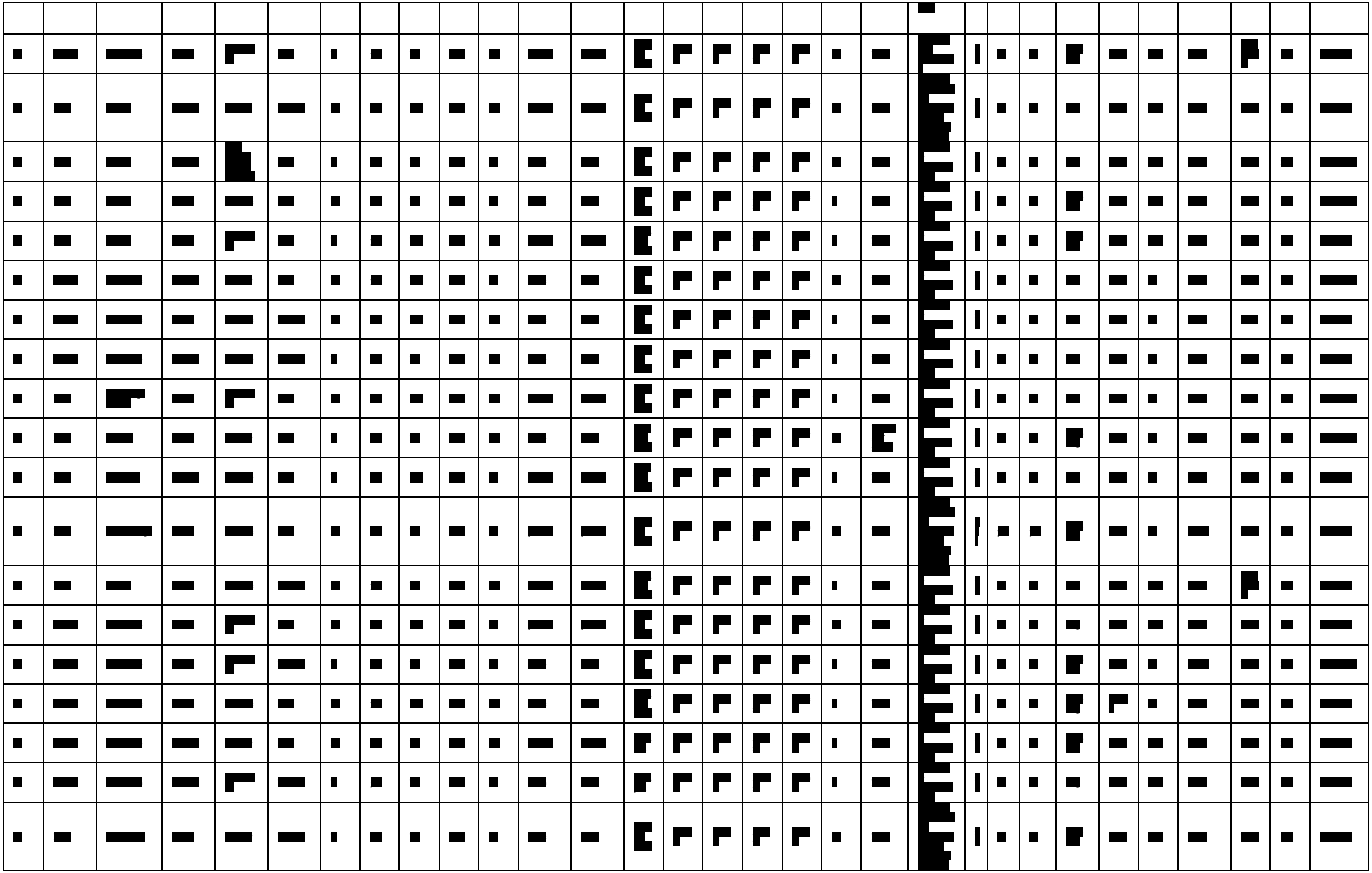

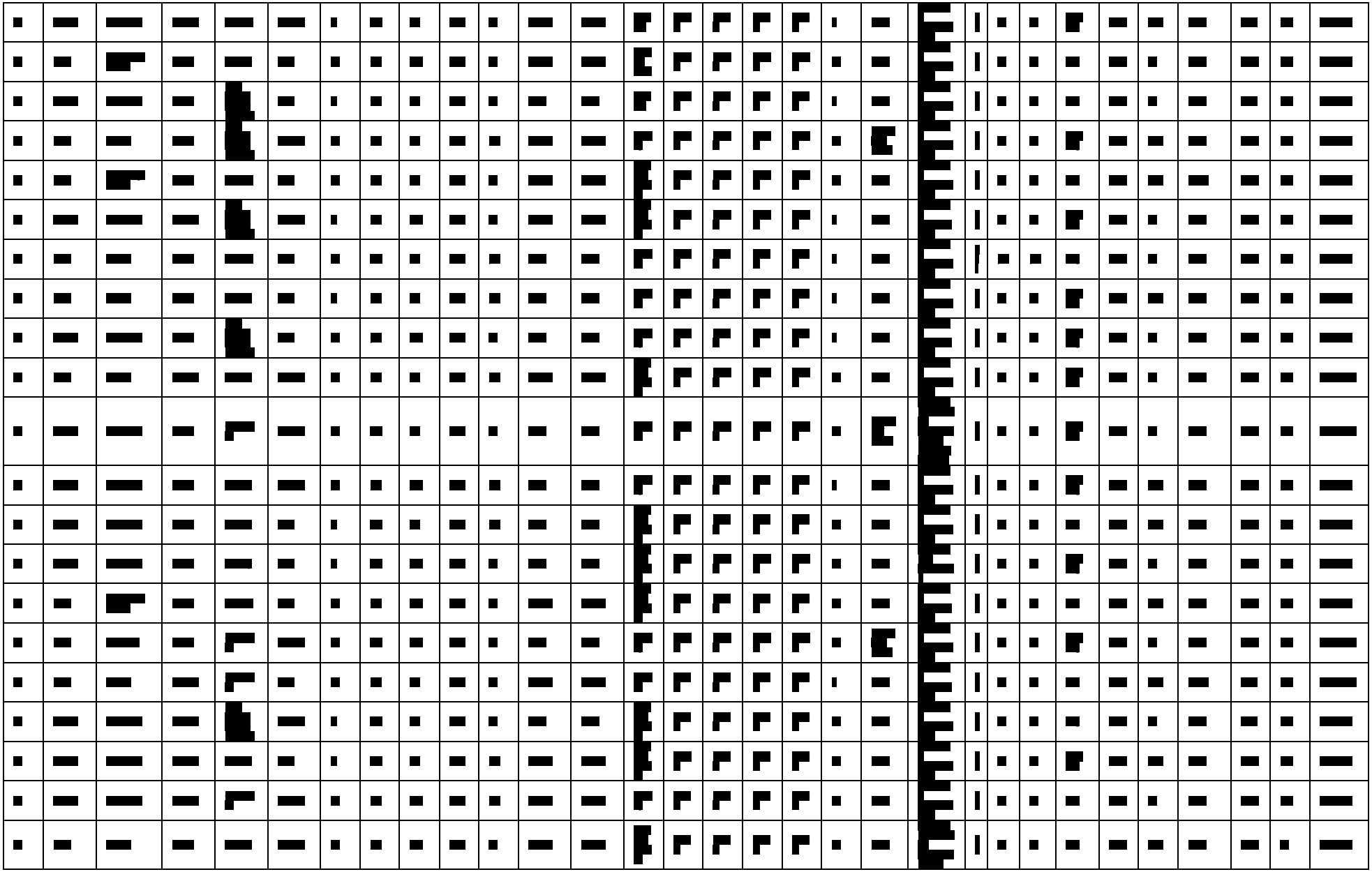

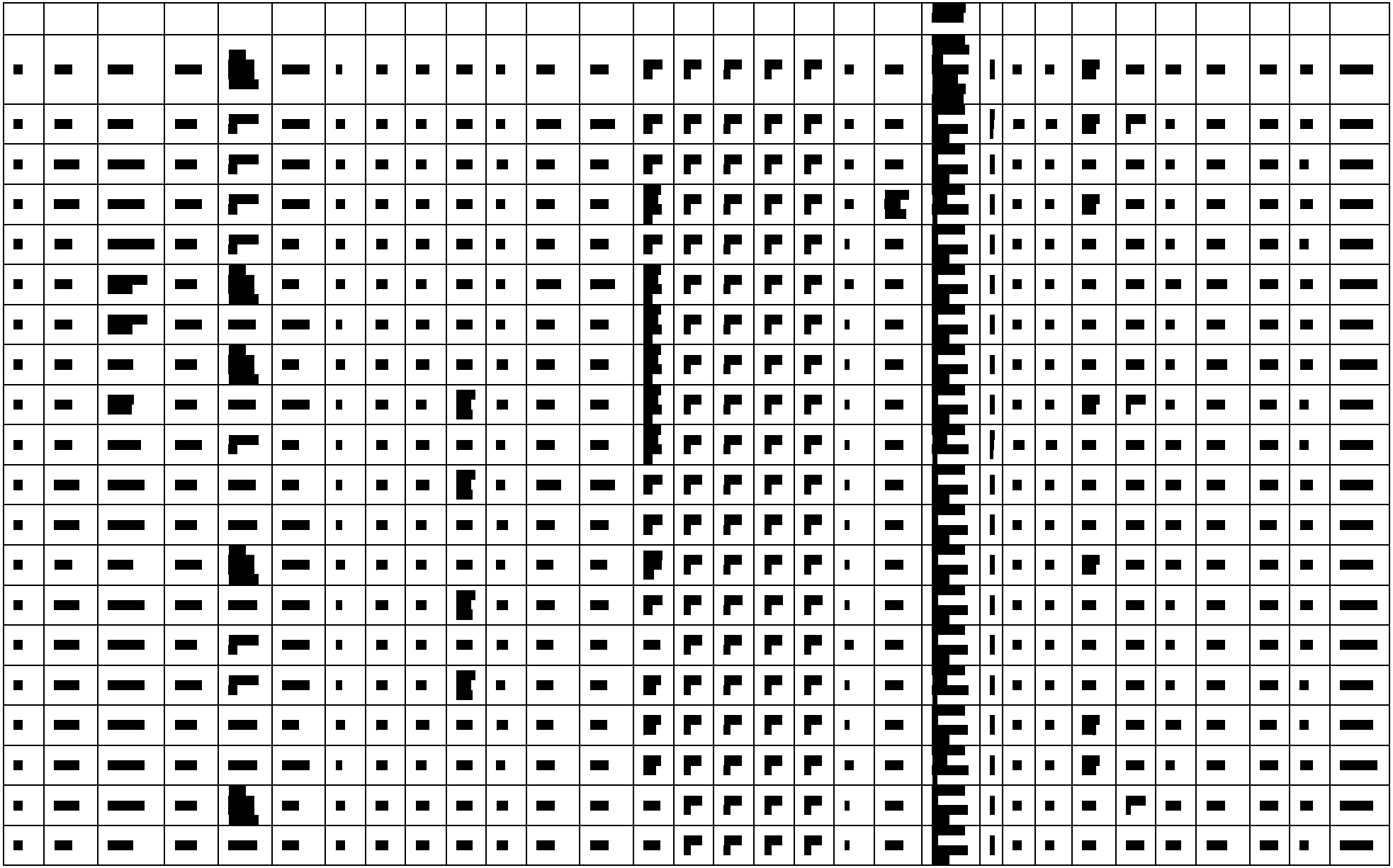

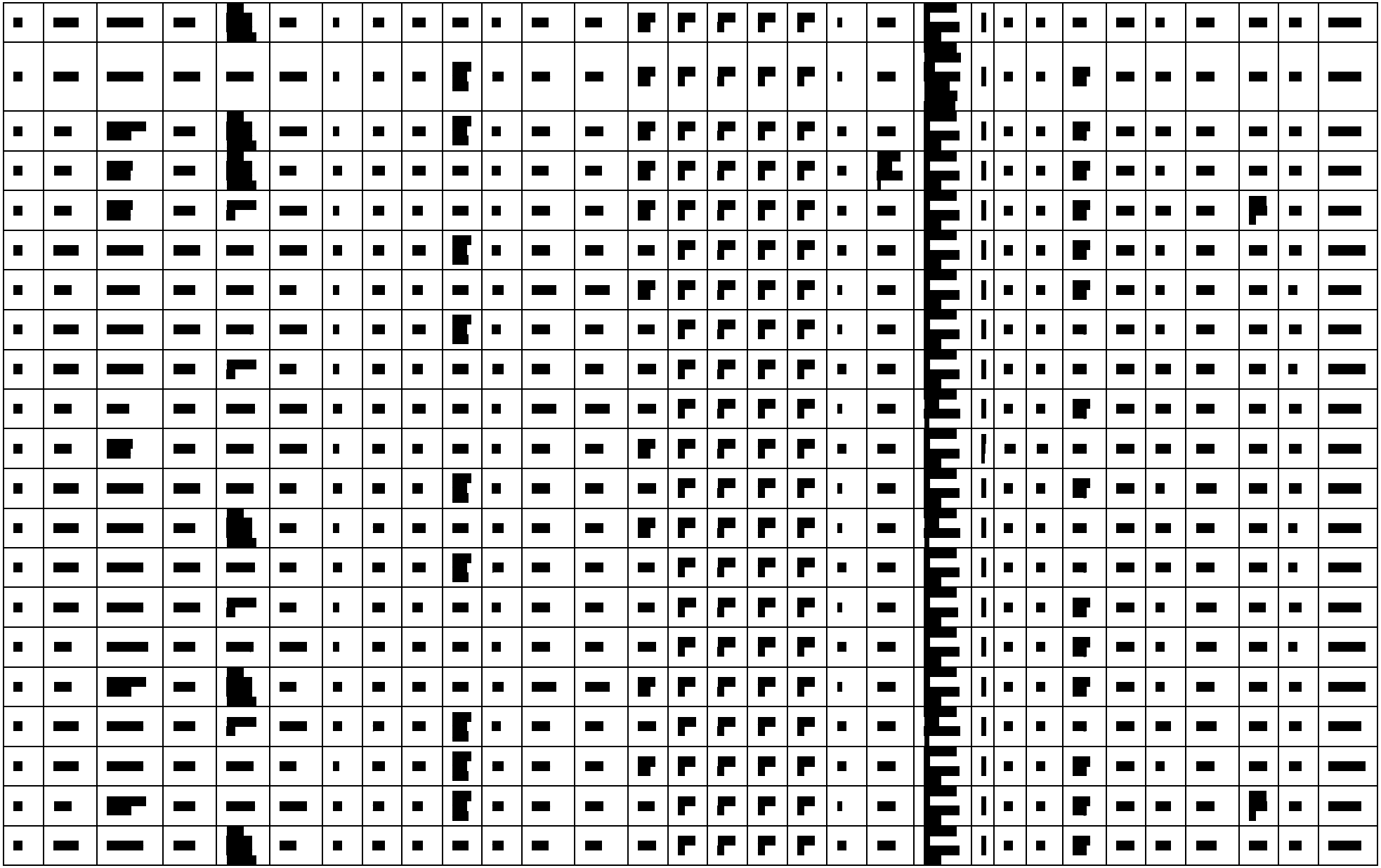

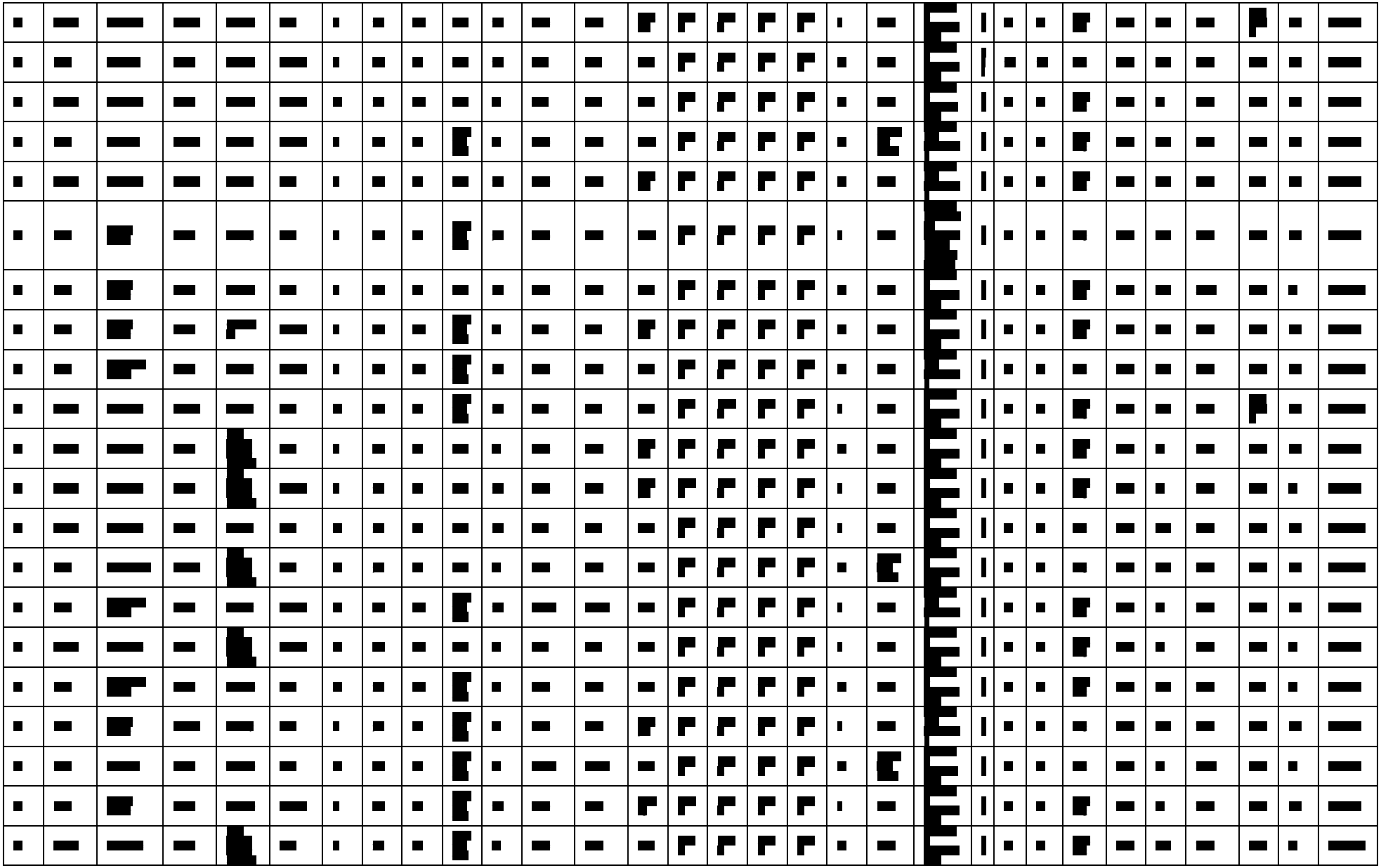

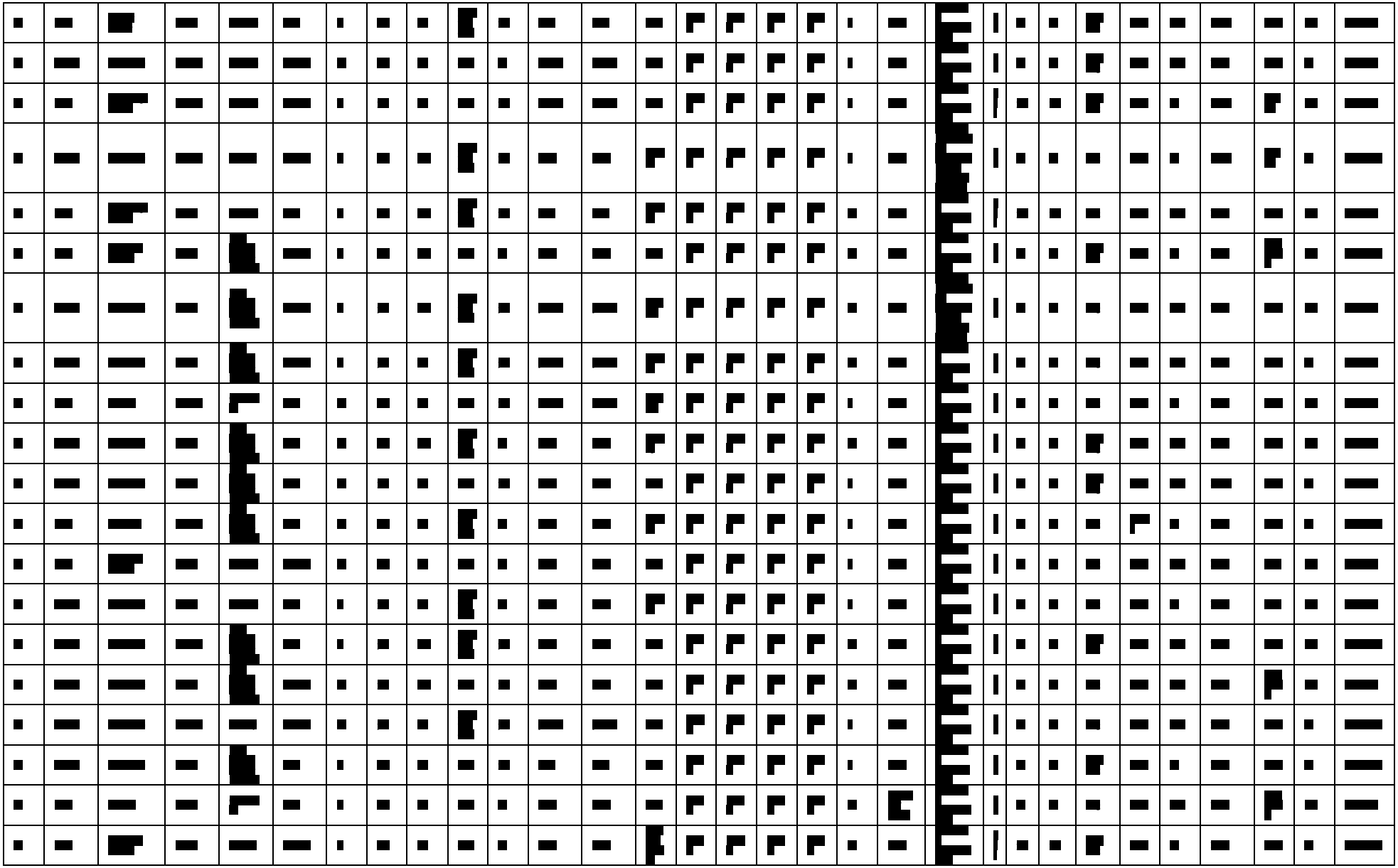

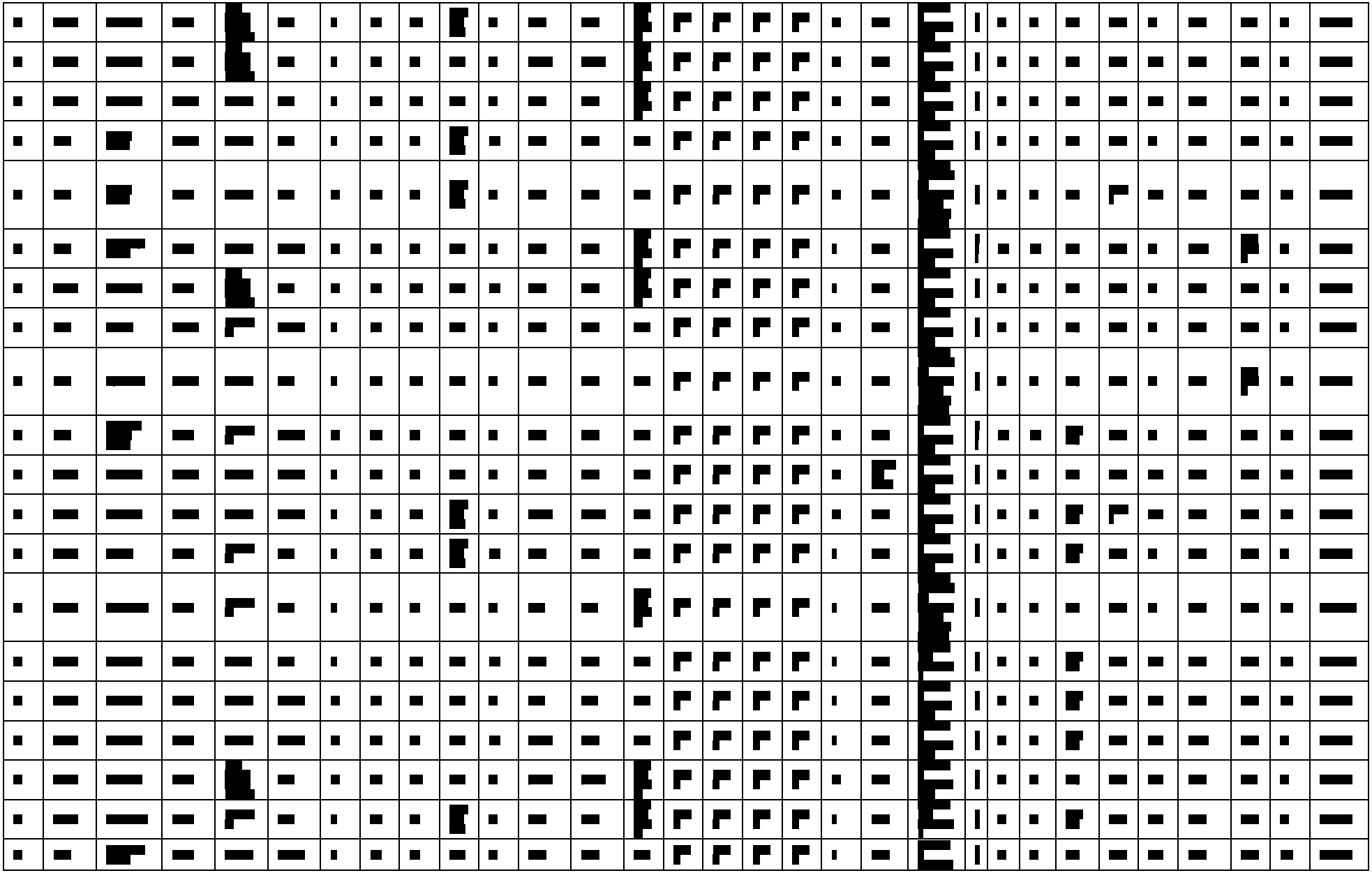

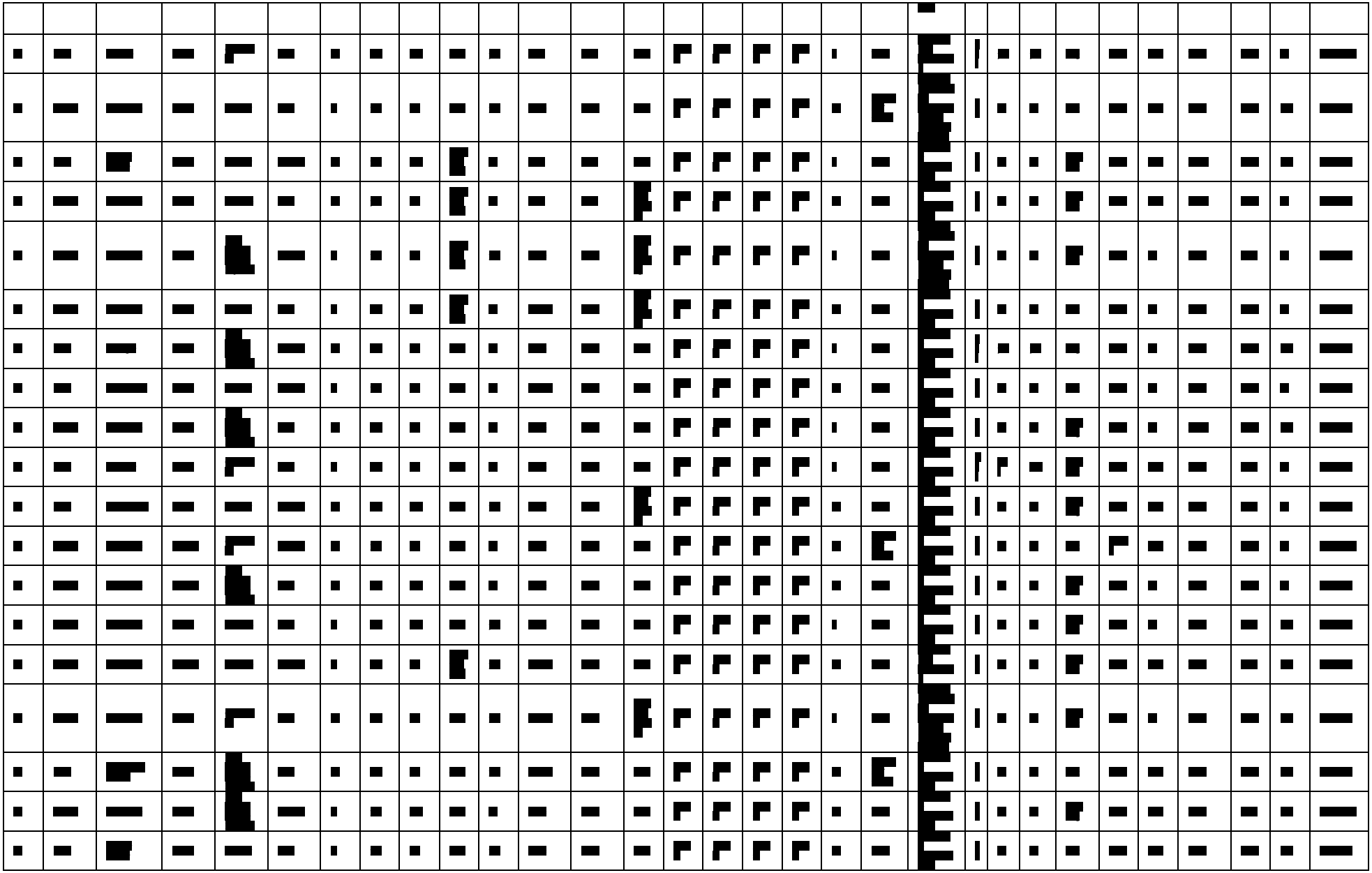
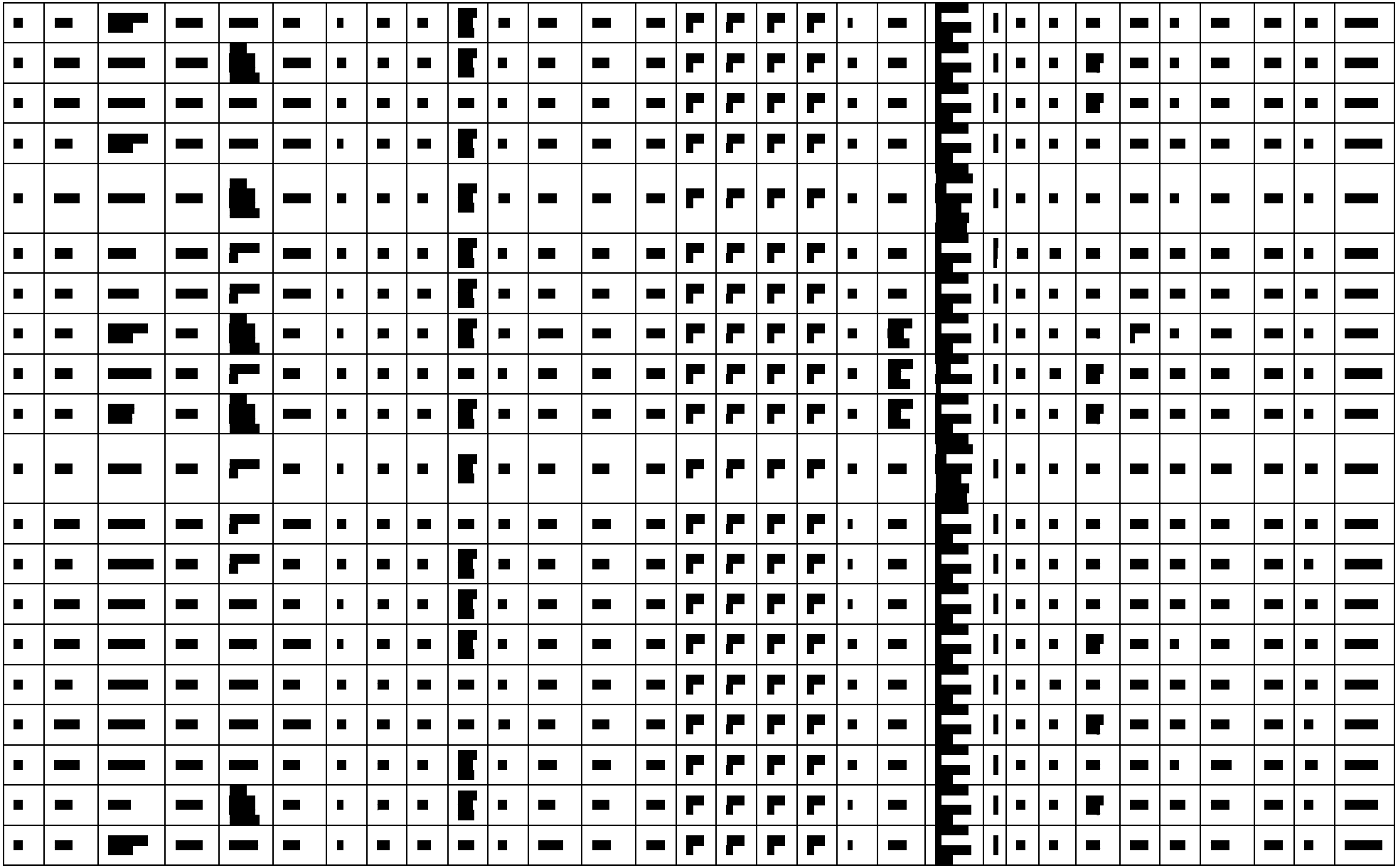
38	Male																													
38	Male																													
47	Female