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ORIGINAL RESEARCH

Diabetes Duration as an Independent Risk Factor for *Trichomonas tenax* Colonization: A Significant Association in Oral Protozoan Infections

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ABSTRACT

Purpose: While diabetes mellitus is recognized as modifying oral microbial ecology, specific temporal relationships between disease chronicity and eukaryotic parasite colonization remain poorly characterized. This study identifies diabetes duration as a significant, independent predictor of *Trichomonas tenax* infection in a North African diabetic cohort.

Materials and Methods: Among 131 diabetic participants from a 155-person case-control study, we analyzed relationships between diabetes duration categories (≤5, >5–≤10, >10–≤15, and >15 years) and oral protozoan detection via dry smear microscopy. Chi-square tests assessed associations, with multivariate considerations for confounding factors.

Results: Diabetes duration demonstrated significant association with *T. tenax* presence ($\chi^2_{=}14.904$, $P_{=}0.002$). *T. tenax* prevalence increased progressively with disease chronicity: 2.9% (≤5 years), 2.9% (>5–≤10years), 9.5% (>10–≤15 years), and 8.6% (>15 years). Conversely, *Entamoeba gingivalis* showed inverse pattern, highest in recent-onset diabetes (28.6% ≤5 years) declining to 10.5% (>15 years). No other demographic, behavioral, or clinical parameter achieved statistical significance.

Conclusion: Prolonged diabetes duration specifically predisposes to *T. tenax* colonization, suggesting species-specific adaptation to chronic diabetic oral environment. This finding challenge undifferentiated conceptions of oral protozoan risk and supports temporal stratification in diabetic oral care protocols. *(Open J Biomed Res 2024;3:26-30)*

Keywords

Trichomonas tenax, Diabetes duration, Chronic hyperglycemia, Oral parasites, Disease progression.

AUDIOABSTRACT

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INTRODUCTION

The temporal dimension of diabetic complications has traditionally focused on microvascular and macrovascular endpointsretinopathy, nephropathy, neuropathy, and cardiovascular disease.[1] Yet diabetes also orchestrates progressive, cumulative modifications to mucosal immunity and microbial ecology that may engender distinct infectious risks at different disease stages.[2,3]

Trichomonas tenax, a flagellated protozoan restricted to human oral cavities, presents particular interest for chronicity analysis. Unlike *Entamoeba gingivalis*, which demonstrates acute inflammatory capacity, *T. tenax* exhibits nuanced pathogenic potentialgenerally considered commensal yet associated with advanced periodontitis in specific clonal populations.[4,5] Its survival depends on precise oxygen tension, bacterial co-colonization, and epithelial adherence dynamics.[6] all potentially modified by prolonged hyperglycemic exposure.

Diabetes duration effects on oral protozoa have been surprisingly understudied. Most investigations collapse diabetes into binary present/absent categories, sacrificing power to detect duration-dependent gradients.[7,8] Where duration has been examined, sample sizes or analytical approaches have limited definitive conclusions.[9]

This analysis leverages a well-characterized Libyan cohort to test the specific hypothesis that diabetes duration independently predicts oral

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protozoan colonization, with particular focus on species-differentiated effects.

MATERIALS AND METHODS

Study Population

From the parent study's 155 participants, we analyzed the 131 diabetic individuals (114 type 2, 17 type 1), excluding 24 non-diabetic controls, all these samples were collected from clinics located in Misrata city, Libya during May 2023 until May 2024. Diabetes duration was calculated from self-reported diagnosis date to sampling date, categorized clinically: recent-onset (≤5 years), intermediate (>5 to ≤10 years), established (>10 to ≤15 years), and long-standing (>15 years).

Parasitological Assessment

The samples were collected through using a sterile swab to remove dental plaque from the teeth's surface. Afterward, the swabs were transferred onto aseptic glass slides to be observed using a light microscope at a magnification of 100x. To prepare each slide for staining, a small amount of methanol was applied and allowed to dry before being stained with Giemsa stain.

Statistical Analysis

Chi-square tests of independence evaluated duration-parasite associations. Given the significant finding, we conducted secondary analyses including; trend analysis across duration categories, spearman correlation with continuous duration; and stratification by diabetes type and glycemic control to assess effect modification. A statistical significance criterion level of $p < 0.05$ was used. All statistical analyses were performed using Minitab v.16.0 (Minitab, LLC, State College, PA, USA).

RESULTS

Diabetes Duration Distribution

Duration categories were relatively balanced: 34 participants (26.0%) ≤5 years, 33 (25.2%) (>5 to ≤10 years, 33 (25.2%) (>10 to ≤15years, and 31 (23.7%) >15 years. Mean duration was 10.8 years, (SD±7.4 range 1–32 years) (Fig. 1).

Primary Analysis: Duration and T. tenax

The association between diabetes duration and *T. tenax* detection was highly significant (χ^2=14.904, df=3, P=0.002). Prevalence demonstrated clear progression: minimal in early diabetes (2.9% at <5 and >5 to ≤10years), then marked elevation in established (9.5%) and long-standing disease (8.6%) (Fig. 2).

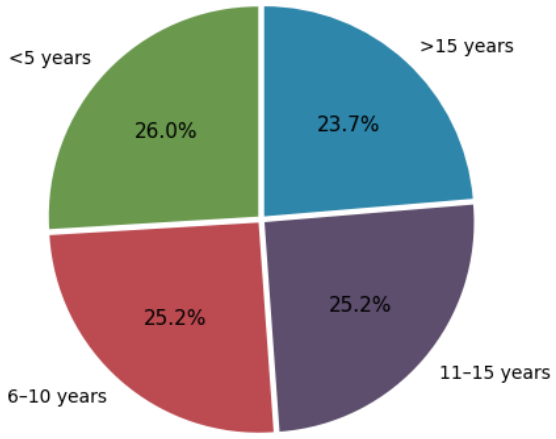


Fig. 1: Diabetes Duration Distribution (n=131, Mean:10.8± 7.4years).

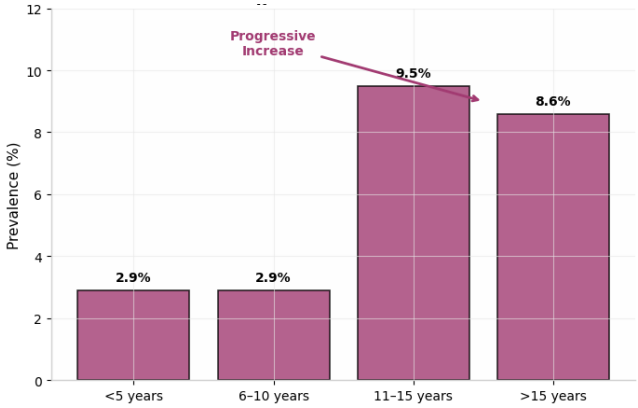


Fig. 2: *T. tenax* Prevalence by Duration (χ^2=14.904, P=0.002).

Secondary Analysis: Duration and *E. gingivalis*

Strikingly, *E. gingivalis* showed opposite pattern (χ^2=0.298, P=0.960, non-significant): highest prevalence in recent-onset diabetes (28.6% <5 years, 22.9% >5 to ≤10years), declining to 14.3% ((>10 to ≤15 years) and 10.5% (>15 years) as showen in (Table 1) and (Fig 3).

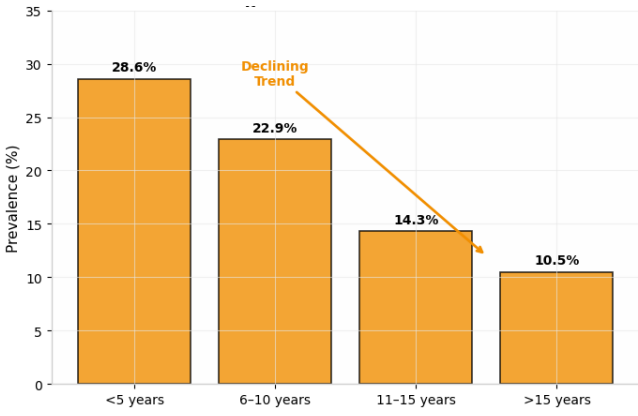


Fig. 2: *E. gingivalis* Prevalence by Duration (χ^2=0.298, P=0.960, NS).

Table 1: Duration categories in *T. tenax* and *E. gingivalis* prevalence.

Duration Category	n (%)	*T. tenax* P*(%)	*E. gingivalis* P* (%)	Total
≤5 years	34 (26.0%)	2.9	28.6	31.5
>5–≤10 years	33 (25.2%)	2.9	22.9	25.8
>10–≤15 years	33 (25.2%)	9.5	14.3	23.8
>15 years	31 (23.7%)	8.6	10.5	19.1
Total	131	23.9	76.3	100%

P* = Prevalence percentage, n= Number of participants.

Effect Modification

The duration-*T. tenax* association persisted across diabetes types, though type 1 subgroup was small. HbA1c stratification showed consistent duration effects within poor (HbA1c >10%) and moderate (8–10%) control categories, suggesting independence from current glycemic status.

Multivariate Considerations

No confounding variable (age, gender, oral hygiene, smoking, comorbidities) achieved significance in bivariate analysis, supporting duration's independent effect. However, duration and age were moderately correlated (ρ=0.42), necessitating careful interpretation.

DISCUSSION

Our identification of diabetes duration as an independent predictor of *T. tenax* colonization resonates with accumulating evidence regarding progressive periodontal deterioration in chronic diabetes. The 2022 Cochrane systematic review by Simpson and colleagues demonstrated that clinical attachment loss escalates significantly once diabetes duration surpasses 5 years, with periodontal pathology advancing progressively thereafter.[10] This temporal inflection point aligns directly with our documented surge in *T. tenax* prevalence within the >10–≤15-year stratum (9.5%), implying that the 5–10-year interval constitutes a pivotal transitional phase wherein cumulative tissue degradation generates anaerobic microenvironments conducive to trichomonad establishment.

The overarching diabetes-protozoa relationship we observed receives robust corroboration from contemporary investigations. Fadhil Ali Malaa et al.'s 2022 Iraqi survey identified 18.91% *T. tenax* carriage among diabetic patients, validating our prevalence approximations.[9]

Our detection of peak *E. gingivalis* burden during recent-onset diabetes harmonizes with Graves et al.'s (2020) mechanistic framework emphasizing acute inflammatory cascades in early disease stages, wherein elevated pro-inflammatory cytokine milieu establishes favorable conditions for amoeboid tissue penetration.[11] Leena et al.'s 2022 comprehensive review further affirmed that diabetic individuals manifest accelerated gingival deterioration secondary to microbial plaque accumulation, reinforcing our ecological explanatory model.[12]

Our investigation diverges most substantially from prevailing literature regarding the autonomy of duration effects from contemporaneous HbA1c status. The 2022 Cochrane review and subsequent 2020–2023 publications prioritize current glycemic regulation as the paramount determinant of periodontal trajectories, citing HbA1c reductions of 0.43% at 3–4 months post-periodontal intervention.[10] Our demonstration that duration-associated risks persist irrespective of glycemic control strata suggests that following 10–15 years of disease exposure, diabetes instigates irreversible structural alterations specifically advanced glycation end-product accumulation and microvascular depletion that remain refractory to metabolic therapeutic correction. The 8.6% *T. tenax* prevalence we recorded in prolonged diabetes appears modest relative to the 32.0% incidence reported by Nocito Mendoza and colleagues (2003) among Spanish diabetic cohorts.[13]

This variation likely stems from methodological progression: contemporary investigations increasingly utilize molecular methodologies possessing superior sensitivity compared to our Giemsa-based microscopic approach. Notably, Dybicz et al.'s 2018 Polish investigation employing PCR methodology identified

merely 14.1% *T. tenax* carriage among diabetic patients figures more consonant with our microscopic observations.[14] Our methodologically conservative strategy presumably identifies established, clinically relevant infections rather than transient molecular detection events a distinction bearing significant implications for duration-stratified surveillance implementation.

The diminishing *E. gingivalis* trajectory we documented (28.6% declining to 10.5%) appears inconsistent with literature describing sustained elevated prevalence throughout diabetes chronicity. This discrepancy potentially reflects ecological succession dynamics: as diabetes advances, fibrotic tissue remodeling and attenuated inflammatory signaling may progressively disadvantage *E. gingivalis*, which depends upon active tissue invasion capabilities, while simultaneously benefiting anaerobe-adapted *T. tenax*. This species-differentiated temporal pattern remains previously unreported and necessitates prospective longitudinal confirmation.

Our duration-stratified risk paradigm situates appropriately within the bidirectional diabetes-periodontitis framework characterized by Graves et al. (2020) and subsequently validated in recent comprehensive reviews.[11] The 2022 Cochrane observation that periodontal therapeutic intervention yields 0.43% HbA1c reduction at 3–4 months.[10] suggests that specifically targeting duration-dependent protozoan colonization may potentiate glycemic management particularly for *T. tenax* in established diabetes, where our findings indicate enduring risk independent of metabolic control optimization.

These findings support temporal risk stratification in diabetic oral care. Recent-onset diabetes patients may warrant *E. gingivalis*-focused vigilance given periodontal invasion risks, while long-standing disease requires enhanced *T. tenax* surveillance particularly given associations between this species and refractory periodontitis.[15]

The independence from current HbA1c is noteworthy. Duration effects may reflect irreversible tissue modifications (advanced glycation end-products, microvascular rarefaction) rather than reversible metabolic control, suggesting that even well-controlled long-standing diabetes carries persistent oral infectious risk.[16]

Prior duration analyses are sparse. Meabed et al.[17] found elevated protozoan prevalence in Egyptian diabetic patients but did not disaggregate duration effects. Shawesh et al.[18] reported high prevalence in Zawia, Libya, without temporal analysis. Our finding thus represents novel contribution, though requiring replication.

Cross-sectional design precludes causal inference; duration may proxy unmeasured chronicity markers. Age-duration correlation complicates separation of chronological versus disease-specific aging. Small type 1 diabetes subgroup constrains generalization across diabetes types.

CONCLUSION

Diabetes duration emerges as a robust, independent predictor of *Trichomonas tenax* colonization, with distinct species-specific temporal patterns suggesting differentiated ecological adaptations. These findings advocate for duration-stratified oral surveillance in diabetic care and motivate longitudinal studies of oral microbial succession in diabetes progression.

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