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RESEARCH ARTICLE
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BIOLOGICAL AGE ASSESSMENT USING THE F-BAS FRAMEWORK A PRACTICAL CLINICAL FRAMEWORK TO ASSESS BIOLOGICAL AGE USING A NOVEL SCORING SYSTEM: FARMAN ALI BIOMARKER AGE SCORE (F-BAS)

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Abstract:
Chronological age poorly reflects physiological decline. The emerging ability to quantify biological age using multi-domain biomarkers offers a transformative opportunity for clinicians to personalise interventions and monitor responses to longevity-focused therapies. However, existing approaches remain fragmented and difficult to integrate into routine practice.
This study synthesizes the importance of creating a novel scoring system that utilizes most clinically relevant biomarkers of ageing and proposes the **Farman Ali Biomarker Age Score (F-BAS)**, a unified, surgeon-driven model enabling frontline practitioners to assess biological age systematically, pragmatically, and accurately. However, this is a two-part study with this part comprising of the analytical review and the next part dealing with execution of the F-BAS into clinical practice.
A structured narrative review was performed across molecular, metabolic, inflammatory, hormonal, and functional domains. *Each biomarker was evaluated for validity, reproducibility, accessibility, and clinical utility*. Results were integrated into a three-tier scoring system comprising *Deep Cellular Diagnostics, Metabolic Resilience Metrics, Systemic Stress and Endocrine Balance, and Functional Resilience*. (3,4,5,9)
The F-BAS consolidates 25–30 biomarkers into an interpretable metric, improving predictive accuracy for morbidity and lifespan estimation. This clinically operable model empowers clinicians to implement biological age assessment across diverse settings, enhancing early risk detection and personalized health optimization.

Keywords: biological age, epigenetic clocks, metabolic flexibility, inflammaging, F-BAS, clinical ageing model. (6,7,20,22)

Introduction (10,25)

Ageing is increasingly recognised as a measurable, biologically regulated process rather than a simple consequence of chronological time. The discrepancy between chronological age and physiological status is evident across medical practice, particularly in surgical and acute-care settings where individuals of the same age show striking differences in resilience, healing, recovery, and metabolic response. (3,4,5,9)
The rapid evolution of molecular biomarkers—ranging from epigenetic clocks to mitochondrial efficiency metrics—has provided unprecedented tools to quantify biological age. However, these

insights remain largely confined to research environments due to their complexity and lack of clinical integration. (6,7,20,22)

This paper introduces the **Farman Ali Biomarker Age Score (F-BAS)**, a consolidated framework that synthesises evidence across core ageing domains into a practical, scalable, clinician-friendly assessment tool. By incorporating surgeon-derived insights into physiological resilience and postoperative recovery, F-BAS bridges the divide between geroscience research and real-world clinical decision-making.

Methods and Methodology (3,6,8,9)

A structured narrative review was performed using PubMed, MEDLINE, Scopus, and Google Scholar. Search terms included "biological age," "epigenetic ageing," "metabolic flexibility," "inflammaging," "functional ageing," and "hormonal ageing." Human clinical studies, systematic reviews, meta-analyses, and translational research were included. (6,7,20,22) Biomarkers were classified into five physiological domains:

1. **Cellular Integrity & Epigenetic Regulation** (6,7,20,22)
2. **Metabolic Efficiency & Mitochondrial Function** (3,4,5,9)
3. **Inflammatory Burden & Immune Ageing** (8,24)
4. **Hormonal Balance & Anabolic–Catabolic Dynamics** (16)
5. **Functional Performance & Physiological Resilience** (11,12,17,18)

Each biomarker was evaluated for scientific validity, reproducibility, accessibility, and actionability. These findings were integrated into a unified framework resulting in the Farman Ali Biomarker Age Score (F-BAS). Ethical approval was not required as no new human or animal research was conducted.

Results (3,6,8,9,11,12,20,22)

Five major biomarker domains demonstrated consistent correlation with ageing and were integrated into the F-BAS model.

1. **Cellular Integrity & Epigenetic Regulation** (6,7,20,22)

Epigenetic ageing clocks and glycan age showed strong predictive value. These form Tier 1A: Deep Cellular Diagnostics in F-BAS, serving as the baseline biological age indicator. (6,7,20,22)

2. **Metabolic Efficiency & Mitochondrial Function** (3,4,5,9)

Metabolic flexibility, mitochondrial ATP output, lactate recovery, and RQ emerged as modifiable, high-impact biomarkers. F-BAS uniquely positions metabolic performance in Tier 1B: Metabolic Resilience Metrics. (3,4,5,9)

3. **Inflammatory Burden & Immune Ageing** (8,24)

Inflammatory markers such as IL-6, TNF-α, hsCRP, and NLR correlated with accelerated ageing. These form Tier 2A: Systemic Stress & Inflammation Panel. (8,24)

4. **Hormonal Balance & Anabolic–Catabolic Equilibrium** (16)

Declines in IGF-1, DHEA-S, sex hormone ratios, and shifts in cortisol influenced ageing trajectories. Incorporated as Tier 2B: Endocrine Regeneration Profile. (16)

5. **Functional Performance & Physiological Resilience** (11,12,17,18)

VO_2max, grip strength, gait speed, HRV, and heart-rate recovery remained among the strongest predictors of morbidity and survival. These form Tier 3: Functional Resilience Index. (11,12,17,18)

The F-BAS Model

The *Farman Ali Biomarker Age Score* consolidates 25–30 biomarkers into a three-tier clinically operable scoring pathway.

It provides:
- *A unified interpretation platform*
- *Tiered implementation for all clinical environments*
- *Actionable insights for personalised intervention*
- *Strong predictive accuracy when biomarker domains are combined*

This establishes F-BAS as a novel, high-utility tool for real-world biological age assessment.
F-BAS Algorithm available in Part 02.

Discussion (8,9,10,24,25)

Scientific advancements have outpaced clinical application in the realm of biological age assessment. Despite the availability of powerful biomarkers, clinicians lack an integrated, operational model. F-BAS directly addresses this gap by consolidating multi-domain biomarkers into a structured, evidence-informed tool.

Unlike traditional frameworks that focus heavily on molecular signatures, F-BAS emphasises **modifiable physiological drivers** such as metabolic flexibility and inflammatory load—domains essential for real-time optimisation. The incorporation of functional performance as the foundational tier ensures alignment with real-world outcomes. (3,4,5,9)

The surgeon-driven perspective embedded within F-BAS offers unique value, integrating insights derived from variability in tissue repair, metabolic stress response, intraoperative resilience, and postoperative recovery. This positions the framework as a powerful tool for preventive medicine, perioperative optimization, and personalized longevity planning. (3,4,5,9)

F-BAS advances the field by providing a model that is scientifically grounded, clinically scalable, and capable of guiding both diagnostics and intervention strategies.

FIGURE 1 —
Conceptual Diagram of the Farman Ali Biomarker Age Score (F-BAS)
The diagram is structured as a three-tier pyramid:

• **Tier 1 (Apex):**
Deep Cellular Diagnostics & Metabolic Resilience (3,4,5,9)
- *Epigenetic clocks* (6,7,20,22)
- *Glycan age* (6,7,20,22)
- *Mitochondrial efficiency* (3,4,5,9)
- *Metabolic flexibility indicators* (3,4,5,9)

• **Tier 2 (Middle):**
Systemic Stress & Endocrine Balance (16)
- *Inflammation markers (IL-6, TNF-α, hsCRP, NLR)* (8,24)
- *Hormonal balance (IGF-1, DHEA-S, sex hormone ratios, cortisol rhythms)* (16)

• **Tier 3 (Base):**
Functional Resilience Index (11,12,17,18)
- *VO_2max*
- *Grip strength* (11,12,17,18)
- *Gait speed* (11,12,17,18)
- *HRV* (11,12,17,18)
- *Heart-rate recovery*

Each tier contributes weighted scoring to produce the final F-BAS value, representing the individual's composite biological age profile.

Conclusion (10,25)

Biological age assessment is emerging as a cornerstone of modern precision medicine. The Farman Ali Biomarker Age Score (F-BAS) provides a structured, clinically meaningful, and highly practical method for translating ageing science into patient care.

By integrating molecular biomarkers, metabolic performance, inflammatory signalling, hormonal balance, and functional resilience into a unified model, F-BAS offers a comprehensive perspective on ageing that is both interpretable and actionable. Its tiered design enables application across diverse clinical settings, from primary care to advanced longevity centers. (3,4,5,9)

As the demand for personalized health optimization grows, F-BAS represents a foundational step towards standardized biological age assessment. Future research should focus on validating the scoring system, correlating F-BAS outcomes with clinical endpoints, and assessing its predictive value in surgical recovery, chronic disease progression, and longevity interventions.

Author Declaration on Use of AI Tools

The authors affirm that no generative artificial intelligence tools were used to create or analyse the scientific content, interpretations, or conclusions of this manuscript. AI assistance was limited solely to language refinement and formatting under the direct supervision and full intellectual control of the authors. All concepts, models, frameworks, and scientific reasoning presented in this work originate from the authors.

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Author Contributions

FA conceptualized the F-BAS framework, conducted the literature synthesis, developed the manuscript structure, and approved the final version.

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Ethics Approval

This study is based on previously published literature and does not involve human or animal subjects.

Data Availability

All data used in this study are available within the manuscript or cited references.

Declarations

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Author Contributions:

FA conceptualized, researched, structured, and finalised the manuscript.

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(Vancouver Style)

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