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The Malta Journal of Health Sciences is a peer–reviewed, open access publication that promotes the sharing and exchange of knowledge in Health Sciences. It provides a platform for novice and established researchers to share their findings, insights and views within an inter–professional context. The Journal originates within the Faculty of Health Sciences, University of Malta.

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Guest Editorial

Culinary Nutrition: Bridging the Gap Between Knowledge and Practice

Petra Jones
Head, Department of Food Science, Nutrition and Dietetics, Faculty of Health Sciences, University of Malta, Msida, Malta.
Melania Spiteri
Pharmacist and Culinary Nutritionist.

Why knowledge is not enough

Non-communicable diseases such as obesity, diabetes, and cardiovascular disease continue to strain health systems worldwide (World Health Organisation, 2025). Despite decades of public health campaigns and a growing body of evidence supporting healthy eating patterns for disease prevention and management, poor diet quality remains one of the leading contributors to premature mortality and disability (Zhu et al., 2025). There remains a significant disconnect between what people know and what they practice; clearly knowledge alone does not change behaviour. The persistent gap between dietary advice and dietary practice highlights an urgent need for education that connects *knowing* with *doing*.

What is Culinary Nutrition?

Culinary Nutrition is emerging as a transformative, inherently interdisciplinary approach that integrates the science of nutrition with the art of cooking, whilst blending medicine, behavioural change and public health (Polak et al., 2025). A consensus definition of *Culinary Nutrition* describes it as the integration of culinary arts and nutrition that applies practical knowledge and skills to improve health. When delivered by health professionals such as doctors and dietitians, the concept is referred to as *Culinary Medicine* (Croxford et al., 2024). Both approaches aim to bridge the gap between theoretical nutrition knowledge and practical application by integrating evidence-based nutritional guidance with food preparation techniques.

Numerous studies suggest that individuals with higher levels of food literacy and cooking skills tend to consume more balanced diets, maintain healthier body weights and experience improved overall health outcomes (Silva et al., 2023, Wolfson et al., 2020; Wolfson & Bleich, 2015). However, modern lifestyles characterised by time pressures, dual-income households, and easy access to convenient, ultra-processed foods have contributed to a decline in home cooking and eroded traditional cooking skills. This shift has been further accelerated by the post-COVID boom in food delivery services, which offer unmatched convenience and have made outsourcing meals easier than ever. Traditional health education efforts, while valuable, often fail to address these practical barriers. Culinary Nutrition offers a solution: it transforms abstract recommendations into tangible, hands-on skills that empower people to make nutritious food choices in the context of their own cultures, preferences, and budgets.

Correspondence to Petra Jones
petra.jones@um.edu.mt
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From theory to practice in higher education

Unlike conventional nutrition instruction, which may be passive or overly theoretical, Culinary Nutrition engages learners in experiential education, transforming abstract recommendations into achievable behaviours. Students plan menus, prepare meals, and evaluate both the sensory and nutritional qualities of food. They learn not only what constitutes a balanced plate but also how to prepare it, modify recipes, and develop flavour while practising ingredient substitutions and sustainable choices; all grounded in an understanding of the nutritional rationale behind their decisions.

Since 2012, the concept of *teaching kitchens*, pioneered by the Goldring Centre for Culinary Medicine at Tulane University, United States, has gained international recognition. Several universities worldwide have now adopted similar initiatives to train healthcare professionals to use nutrition and healthy cooking as tools for patient care. Accredited dietetic education programmes are beginning to incorporate culinary training in their curricula (Croxford et al., 2024). This growing movement reflects a shift toward more practical, food-focused healthcare education; one in which nutritionists and dietitians are uniquely positioned to lead by combining scientific expertise with hands-on culinary skill to promote lasting behaviour change.

Our local response

Reflecting this international momentum, the University of Malta's Department of Food Science, Nutrition and Dietetics at the Faculty of Health Sciences has embedded Culinary Nutrition into its four-year undergraduate programme; the B.Sc. (Hons.) Applied Food and Nutritional Sciences. These practical sessions expose students to the everyday realities faced by patients, including limited time, budgets, and cooking confidence and help future nutrition professionals design advice that is realistic, empathetic, and actionable. Students learn to prepare meals that align with dietary guidelines while being affordable, culturally appropriate, and appealing. This initiative reflects a broader pedagogical shift within the department: to ensure that nutrition education moves beyond lectures and laboratories into kitchens.

The integration of Culinary Nutrition inspired wider departmental engagement with sustainability and cultural identity. During the sessions, students prepared dishes that reflected the healthy eating principles at the heart of both culinary nutrition and the Mediterranean diet, seasonal, locally sourced, minimally processed, and rich in plant-based foods that are culturally adaptable and inherently sustainable. Building on these experiences, students were later invited to develop and submit recipes that applied the same concepts. These collective efforts culminated in the department's first digital publication, *The Mediterranean Sustainable Kitchen: A Recipe Collection* (Jones & Spiteri, 2025), a freely available eBook that reinforces the commitment to community education by showcasing affordable, culturally rooted, and health-promoting meals.

Building capacity

While enthusiasm for Culinary Nutrition is growing, implementation is not without challenges. The most immediate barrier is the lack of dedicated teaching kitchen facilities within academic institutions. Without a dedicated space and equipment, practical sessions can only be offered on a limited scale, a limitation that likewise applies to the Faculty of Health Sciences where space constraints restrict the scale of activities. Securing institutional investment in teaching kitchens would allow these programmes to expand, fostering richer interdisciplinary collaboration.

Beyond infrastructure, there is an opportunity to extend Culinary Nutrition beyond undergraduate education into postgraduate training and continuing professional development. Equipping practising health professionals with culinary and behavioural-change skills could strengthen dietary counselling and public health practice. International shared learning models between dietitians, nutritionists, and chefs that combine nutrition science with hands-on culinary training illustrate a global move toward food-focused education that promotes sustainable, health-oriented and culturally relevant food environments (Krenek et al., 2024).

Looking ahead

The future of Culinary Nutrition lies in collaboration and consolidation. Establishing shared curricular frameworks, competencies, and evaluation standards across institutions will help ensure consistency, quality, and scalability. As the field continues to evolve alongside Culinary Medicine, it has the potential to serve as a unifying model for health professional education, one

that nurtures practical skills, cultural awareness, and sustainability.

Ultimately, embedding culinary competence into nutrition education is not merely an academic enhancement; it is a public health imperative. By equipping current and future professionals with the skills to translate evidence into everyday food choices, we can help address the global challenges of chronic disease, climate change, and nutrition inequity, hence bringing the science of nutrition to life for the benefit of people and the planet.

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Short Communication

Trichophyton benhamiae as the Causal Agent of Tinea Faciei: The First Case Report in Malta

Melissa M. Formosa
Department of Applied Biomedical Science, Faculty of Health Sciences, University of Malta, Msida, Malta.
Centre for Molecular Medicine and Biobanking, University of Malta, Msida, Malta.
Stephen Decelis
Mycology Laboratory, Pathology Department, Mater Dei Hospital, Msida, Malta.
Arianne Muscat
Mycology Laboratory, Pathology Department, Mater Dei Hospital, Msida, Malta.
Jeanelle Bugeja
Mycology Laboratory, Pathology Department, Mater Dei Hospital, Msida, Malta.
Luigi A. Galea
Mycology Laboratory, Pathology Department, Mater Dei Hospital, Msida, Malta.
Jessica M. Vella
Mycology Laboratory, Pathology Department, Mater Dei Hospital, Msida, Malta.
Claire Marantidis Cordina
Mycology Laboratory, Pathology Department, Mater Dei Hospital, Msida, Malta.
Department of Pathology, Faculty of Medicine and Surgery, University of Malta, Msida, Malta.
Rodianne Abela
Mycology Laboratory, Pathology Department, Mater Dei Hospital, Msida, Malta.
Department of Pathology, Faculty of Medicine and Surgery, University of Malta, Msida, Malta.
Christopher Barbara
Mycology Laboratory, Pathology Department, Mater Dei Hospital, Msida, Malta.
Department of Pathology, Faculty of Medicine and Surgery, University of Malta, Msida, Malta.
Stefan Laspina
Department of Pathology, Faculty of Medicine and Surgery, University of Malta, Msida, Malta.
Dawn M. Caruana
Saint James Hospital, Gorg Borg Olivier Street, Sliema, Malta.

Correspondence to Melissa Marie Formosa
melissa.m.formosa@um.edu.mt
Received: 2.5.2025
Revised: 31.5.2025
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Abstract

Trichophyton benhamiae is an emerging zoonotic dermatophyte increasingly recognised as a cause of inflammatory mycosis in humans, particularly following contact with infected animals. We report the first documented case of *T. benhamiae* infection in Malta in an 8-year-old girl who presented with a single itchy annular patch on her right cheek. The patient had a recent history of close interaction with a symptomatic

pet guinea pig, a known reservoir of this pathogen. Laboratory examination in the form of mycological culture and proteomic analysis by mass spectrometry confirmed the presence of *T. benhamiae*. The patient responded well to topical antifungal therapy. A few months later, three other cases of *T. benhamiae* infection were also identified in Malta highlighting the presence of an emerging dermatophyte causing inflammatory mycosis. This case underscores the diagnostic challenges associated with *T. benhamiae*, as its presentation often mimics that of more common dermatophytes, potentially leading to misdiagnosis or delayed treatment. Futhermore, increased awareness is essential to prevent the spread of zoonotic mycosis.

Keywords: *T. benhamiae*; Medical dermatology; Tinea faciei; Zoonosis; Mycology

Introduction

T. benhamiae is an emerging dermatophyte that has been the cause of rising zoonotic infections in humans over the past two decades. An increase in the keeping of domestic pets, especially guinea pigs, has contributed to a surge of cases worldwide, including Czech Republic, Poland, Germany, Italy, Finland, Switzerland, Iran, Egypt, China, Taiwan, Japan, and the USA (Arias, Diaz, & Erdem, 2021; Berlin et al., 2020; Čmoková et al., 2020; Tan et al., 2020). We hereby report the first human case of *T. benhamiae* infection in Malta, including the clinical presentation, the laboratory investigations conducted, and the treatment regime followed.

Case Presentation

An 8-year-old healthy female presented at the clinic with a 2-week history of an isolated, itchy annular patch composed of pink papules and scanty fine scales on the right cheek measuring 2cm in diameter (Figure 1a). She exhibited no systemic symptoms, such as fever or lymphadenopathy, and hence no blood investigations were performed. She was initially treated with Mupirocin 2% ointment twice daily for 2 weeks with no benefit. Thereafter, a twice daily application of Terbinafine hydrochloride 1% cream for two weeks produced minimal effect. She was therefore referred for mycological examination. Of note, the patient admitted to owning a healthy guinea pig and to frequent close facial contact. She also had frequent contact with a friend's guinea pigs which had progressive fur loss, and which subsequently died. No veterinary assessment of the animals was performed.

Findings

Mycology skin scrapings were subjected to direct microscopy using 10% potassium hydroxide (KOH) which did not reveal the presence of fungal elements, possibly due to the recent use of topical antifungal agents. The sample was also cultured on Sabouraud dextrose agar with chloramphenicol (SDC) and SDC with cyclohexamide (SDCC) at 30°C for up to 28 days. Growth was observed on both culture media after two weeks incubation, starting with white fluffy colonies that eventually yielded white to beige radiating colonies having velvety raised centres and powdery to granular edges (Figure 1b). On reverse, the colonies were intensely pigmented ranging from bright orange to dark reddish-brown (Figure 1c). Lactophenol cotton blue mount from the colonies showed septate hyphae with laterally arranged or terminally inserted single-celled spherical microconidia grouped in clusters, whereas spiral bodies and macroconidia were absent. Proteomic analysis using the matrix-assisted laser desorption ionisation-time of flight (MALDI-TOF) mass spectrometry (VITEK® MS, bioMérieux, Lyon, France) identified *T. benhamiae* with a confidence level of 99.9% (based on manufacturer's reference values and stain database). Ongoing use of Terbinafine hydrochloride 1% cream for an additional 4 weeks resulted in complete clearance.

Discussion

T. benhamiae was initially described in 1967 as *Arthroderma benhamia* (Ajello & Cheng, 1967). Two phenotypic variants, denoted as the 'yellow' and 'white' strains, have progressively been isolated in the USA and Europe. The yellow strain corresponds to *T. benhamiae var. luteum*, whereas the white strain corresponds to *T. benhamiae var. benhamiae* (prevalent in the USA), *T. japonicum* (frequent in Asia), and *T. europaeum* (the second commonest species infecting guinea pigs in Europe). The white strain closely resembles *T. mentagrophytes* which was subsequently reclassified as *T. benhamiae* following ribosomal sequencing (Berlin et al., 2020; Čmoková et al., 2020). Indeed, our initial colonies mimicked *T. mentagrophytes* culture growth highlighting the importance of careful mycological investigations supplemented with superior identification

techniques, particularly when routine macroscopic and microscopic analyses are not as distinct.

In humans, *T. benhamiae* infection manifests most commonly in young individuals with highly inflammatory lesions of tinea corporis (Sommer et al., 1999) and tinea faciei (Arias et al., 2021; Tan et al., 2020), primarily as a result of frequent contact with infected animals, hair or scales, and outdoor activities (Arias et al., 2021; El-Heis, Borman, Szekely, & Godfrey, 2016). Tinea capitis (including kerion), tinea cruris, tinea manuum and rarely onychomycosis may also occur. Although usually solitary, multiple skin lesions have been reported in immunocompromised individuals (Budihardja, Freund, & Mayser, 2010). Lesions may be painful or itchy, and some cases reported associated fever. Familial cases are common. The growing diversity of wild and exotic animals housed as domestic pets has consequently aided in the increasing incidence of *T. benhamiae* infections. Culprit pets, including guinea pigs, rabbits, degus, cats, dogs and foxes may be asymptomatic carriers (Drouot, Mignon, Fratti, Roosje, & Monod, 2009; Peano et al., 2022; Tan et al., 2020).

Terbinafine is the most effective agent against widespread and inflammatory dermatophytosis. Alternatively, fluconazole, itraconazole and griseofulvin have been successfully used (Arias et al., 2021; Gupta & Drummond-Main, 2013; Sips et al., 2021). Systemic treatment is generally indicated for extensive infections, tinea capitis and in immunocompromised patients. Since the identification of the presented case, three other cases of *T. benhamiae* have been isolated locally within a 9-month period, including a 40-year-old female with tinea cruris, a 23-year-old male with tinea capitis and a 52-year-old female with tinea manuum.

Conclusion

The study highlights the importance of increased awareness of this growing entity, and the role that a multidisciplinary approach involving clinicians and laboratory scientists plays for correct and timely diagnosis. Moreover, early diagnosis, appropriate antifungal therapy, and public education about pet-associated fungal risks are essential in managing this growing public health concern.

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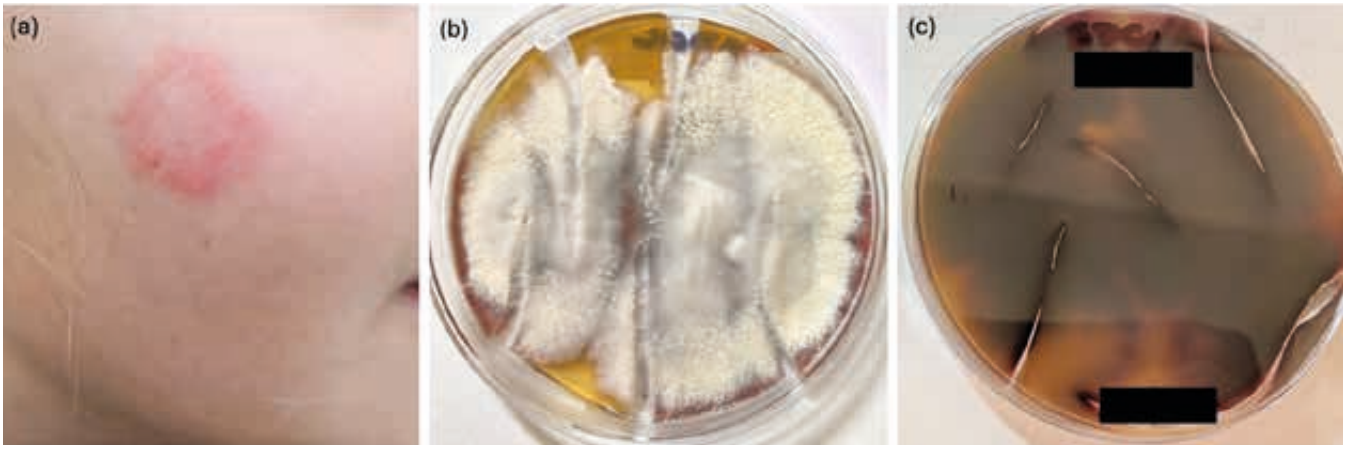

Figure 1.
(a). Clinical appearance of the annular rash on the right cheek (2cm diameter) before treatment
(b). Macroscopic appearance of *T. benhamiae* on SDCC showing white colonies with velvety centres and powdery to granular edges on the surface
(c). Orange to reddish-brown pigment on the SDC reverse plate.

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Review Article

The Effects of Pulmonary Rehabilitation on Bone Mineral Density in Patients with known Pulmonary Conditions: A Narrative Review

Melanie Axiak
Department of Physiotherapy, Faculty of Health Sciences, University of Malta, Msida, Malta.
Anabel Sciriha
Department of Physiotherapy, Faculty of Health Sciences, University of Malta, Msida, Malta.
Tonio. P. Agius
Department of Physiotherapy, Faculty of Health Sciences, University of Malta, Msida, Malta.

Abstract

Pulmonary Rehabilitation (PR) is a standard treatment for patients diagnosed with Chronic Obstructive Pulmonary Disease (COPD) with exercise training being a key component of this intervention. COPD patients have a high prevalence of osteopenia and osteoporosis, primarily due to corticosteroid use, which significantly increases their risks of falls and fractures. Given the substantial impact of fractures on COPD patients, preventative measures are essential to mitigate bone mineral density loss and reduce fracture risk and associated adverse consequences.

Research on the effects of exercise on BMD in COPD patients is notably limited. This review aims to examine the effects of PR on BMD, fall and fracture risks, and functional exercise capacity in patients with COPD. A systematic search was conducted using MEDLINE Complete (via EBSCOhost), AgeLine (via EBSCOhost), Google Scholar and HyDi (Hybrid Discovery) for articles published between 2003 and 2021. The PICO (Population, Intervention, Comparator, Outcomes) framework was used to formulate the research question, define inclusion criteria and report the study characteristics: (P) subjects with stable COPD, (I) PR, (C) no PR during the duration of the study and (O) BMD, risks of falls and fractures, and functional exercise capacity.

Critical evaluation, data abstraction and synthesis were conducted by the authors. Evidence suggests that exercise training positively influences BMD outcomes. However, the evidence regarding the effects of PR on BMD in COPD patients, along with its impact on fall and fracture risks, and functional exercise capacity remains insufficient. This highlights the need for further research. Implementing PR may help COPD patients prevent additional BMD loss, reduce fall and fracture risks, and minimise related complications, ultimately improving their health-related quality of life and long term prognosis.

Keywords: Pulmonary Rehabilitation, Exercise, Physical Activity, Chronic Obstructive Pulmonary Disease, Osteoporosis, Bone Mineral Density

Correspondence to Ms Melanie Axiak
melanie.axiak.14@um.edu.mt
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Introduction

Reduced bone mineral density (BMD) is a significant comorbidity in patients with pulmonary conditions, particularly Chronic Obstructive Pulmonary Disease (COPD) (Ma et al., 2022; Taveira-DaSilva et al., 2005;

Zeng et al., 2019). Osteoporosis, as defined by the World Health Organisation (WHO), is present when BMD is "2.5 standard deviations or more below the young adult mean (a T-score of <-2.5 SD)" (WHO, 1994), leading to compromised bone strength and an increased risk of fractures, particularly in the vertebrae and femur (Bouvard et al., 2021; Meyer et al., 2019). Among pulmonary conditions, COPD is most closely associated with osteoporosis, with affected patients experiencing reduced BMD two to five times more frequently that age-matched healthy individuals (Chen, et al., 2019; Ma et al., 2022).

COPD is a multisystem disease characterised by progressive and partially reversible chronic airflow limitation, accompanied by an increased inflammatory response to noxious particles or gases. It is a significant global burden, with rising global prevalence and mortality rates. In 2019, COPD accounted for approximately 455 million cases and 3.9 million deaths worldwide (Vos et al., 2020), making it the third leading cause of death globally, with projections indicating it may become the leading cause within the next decade (The Global Initiative for Chronic Obstructive Pulmonary Disease [GOLD] guidelines 2021 cited in Gupta et al., 2021). While COPD is largely preventable and manageable, its pulmonary and extra-pulmonary manifestations, such as osteoporosis, significantly impact disease severity and quality of life (The GOLD guidelines 2021 cited in Gupta et al., 2021).

Osteoporosis in COPD patients is associated with multiple risk factors, including systemic inflammation, corticosteroid use, smoking, low body mass index, hypogonadism, Vitamin D deficiency, pulmonary dysfunction, and physical inactivity (Lehouck, Boonen et al. 2011, Romme, Geusens et al. 2015, Sarkar, Bhardwaj et al. 2015). Additionally, COPD patients face an elevated risk of falls due to lower limb weakness, impaired postural control, and functional limitations (Lawlor et al., 2003; Roig et al., 2009). Osteopenia, a precursor to osteoporosis, (T Score between – 1 to – 2.5 standard deviations) is a key indicator of fracture risk in these individuals (WHO, 1994).

Fractures in turn can exacerbate COPD symptoms, decrease lung function, and initiate a cycle of impairment that further reduces physical function and daily activity levels. This cycle includes fear of falling, depression, and reduced social interaction, leading to further muscle and bone loss and diminished overall physical capacity (Clynes et al., 2020; Friedman & Mendelson, 2014; Ji & Yu, 2015; Kerr et al., 2017; Liao et al., 2016; Sarkar et al., 2015).

Management of osteoporosis and osteopenia in COPD involves pharmacotherapy, smoking cessations, disease monitoring, and Pulmonary Rehabilitation (PR) (Bollmeier & Hartmann, 2020). Pulmonary Rehabilitation (PR), a standard non-pharmacological intervention for COPD (Vestbo et al., 2013), includes exercise training ~ a cost effective, non-invasive strategy that enhances mechanical bone loading, preserves BMD, and improves muscle strength, balance, and coordination (Brooke-Wavell et al., 2022; Cheung & Giangregorio, 2021; Compston et al., 2017; Marini et al., 2020; Mohammad Rahimi et al., 2021; Spruit et al., 2013). These benefits collectively reduce fall risk and fracture likelihood. However, research on the direct effects of PR on BMD, fracture prevention, and fall risk in COPD patients remains limited (Jarvinen et al., 2008).

Due to this gap in research, this narrative review primarily examines the effects of PR on BMD in COPD patients but also considered findings from studies on other pulmonary conditions such as cystic fibrosis (CF) and lymphangioleiomyomatosis (LAM). While these conditions differ in pathophysiology and typically affect younger demographics, their association with reduced BMD and the role of PR in mitigating bone loss provide valuable insights into potential benefits from COPD patients.

Review of the Literature

Aims

The aim of this review is to determine whether PR affects BMD, the risks of falls and fractures and functional exercise capacity in patients diagnosed with COPD. The research question posed is: *Does PR have an effect on BMD, on risks of falls and fractures and on functional exercise capacity in patients with stable COPD*?

Search Methods

A narrative review design was selected to facilitate and a comprehensive and critical analysis of the research evidence. This review employed the population (P), intervention (I), comparator (C) and outcomes (O) (PICO) framework to formulate the research question, define inclusion criteria and report study characteristics. Table 1 outlines the key PICO search terms.

Table 1: PICO search terms			
Population	**Intervention**	**Comparison**	**Outcome**
Subjects with stable COPD	PR intervention	PR intervention compared to no PR intervention during the duration of the study	BMD Risks of falls and fractures Functional exercise capacity

Relevant studies were identified through searches in the following databases: MEDLINE Complete (via EBSCOhost), AgeLine (via EBSCOhost), Google Scholar and HyDi (Hybrid Discovery). The keywords used included Pulmonary Rehabilitation, Exercise, Physical Activity, Chronic Obstructive Pulmonary Disease, Osteoporosis, Bone Mineral Density and Bone Mineral Status.

Search Strategy

The search strategy yielded a total of 597 research articles through the selected databases using the specified keywords, restricting results to peer-reviewed, English Language articles involving human participants. Subsequently, a secondary search was conducted from references cited in reviewed articles, yielding an additional 3 research articles. The search process is illustrated in the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA) flow diagram (Page et al., 2021) (Figure 1), which outlines the identification, screening, inclusion, and exclusion of studies based on the inclusion and exclusion criteria detailed in Table 2.

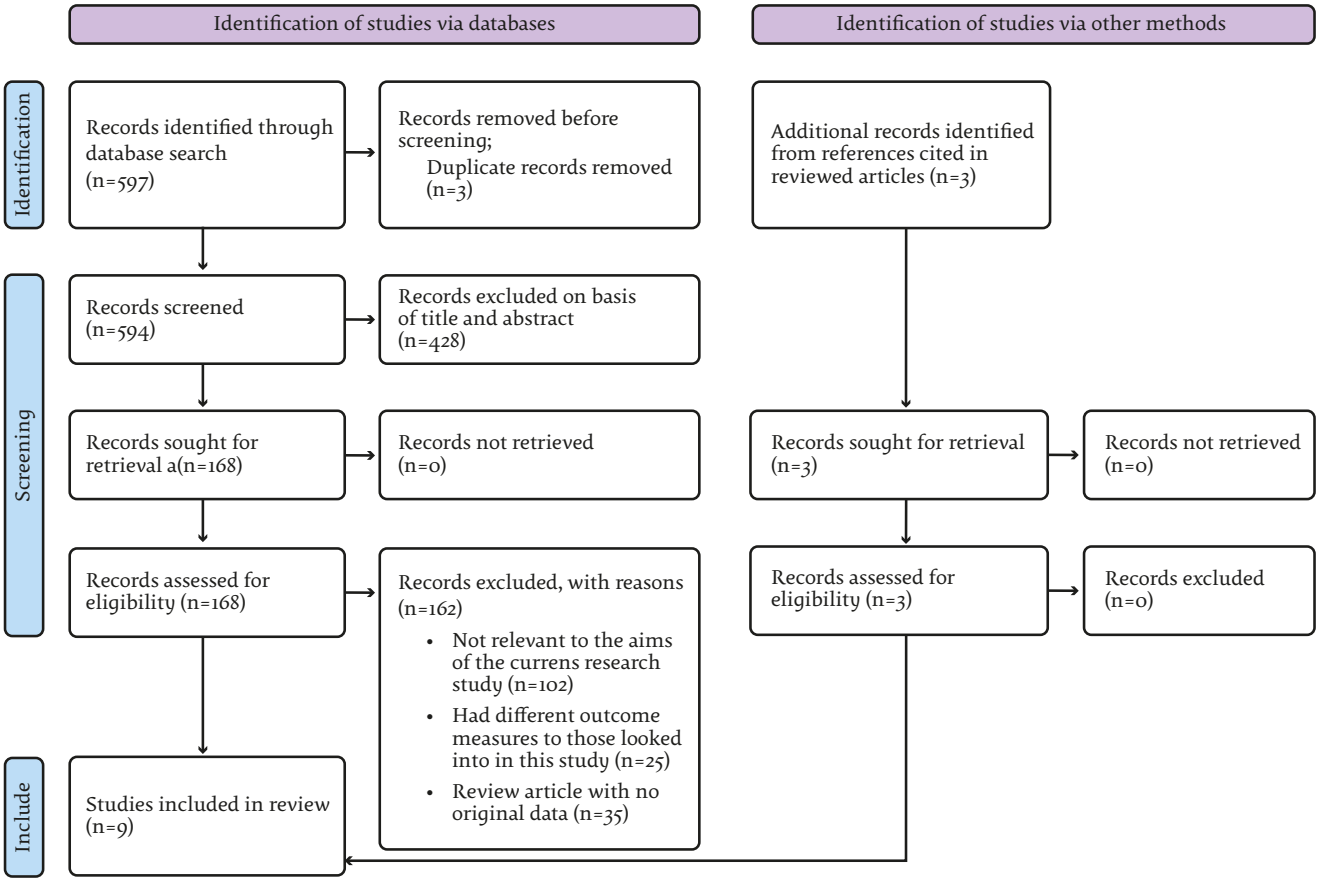

Figure 1: The "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" Flow Diagram (Adapted from Page et al., 2021)

Ultimately, 9 articles were selected for review. Because of the limited number of eligible articles, the review expanded its scope to include studies published between 2003 and 2021 and included studies on pulmonary conditions other than COPD.

Table 2: Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Publication date	A study published less than 12 years ago	Study published more than 12 years ago
Patient selection	Subjects have a confirmed COPD or any other lung condition	Study which included subjects with unconfirmed COPD or any other lung condition
Aims	The study aims to investigate whether exercise training/PR has an effect on one or more of the following: BMD, risks of falls and fractures and functional exercise capacity in patients diagnosed with COPD or any other lung condition	The study's aims not related to the current narrative review's aims
Outcome measures	The study assessed one or more of the following outcome measures: BMD, risks of falls and fractures and functional exercise capacity	The study does not assess one or more of the primary outcome measures
Originality of data	Article contains original data	Article lacking original data

Study Selection and Quality Appraisal

Nine articles were included in this narrative review, and their characteristics are summarized in Table 3. These studies examined the effects of exercise training/PR on BMD, the risk of falls and fractures and functional exercise capacity in patients with COPD or other lung conditions.

Table 3: A summary of the studies reviewed through this narrative review

Author and Year of Publication	Title	Study Design and Outcome Measures	Key Findings	Strengths and Limitations
Frangolias et al. (2003)	Role of Exercise and Nutrition Status on Bone Mineral Density in Cystic Fibrosis	A cross-sectional and prospective study was designed in which 67 subjects diagnosed with Cystic Fibrosis (CF) were recruited. Outcome measures: Lung function test, Exercise capacity (VO2max) assessed during a progressive incremental exercise test to maximal effort, BMD of lumbar spine, proximal femur and whole body using the DEXA scanner, documentation of corticosteroid use, anthropometric measures, CF severity assessed using the Shwachman-Kulczycki (S-K) score (Shwachman & Kulczycki, 1958), information gathered on subjects` patterns of physical activity, pulmonary status and nutritional status, thoracic vertebral compressions' evidence obtained through chest and lateral spine radiography, fracture history collected by the Canadian Multicenter Osteoporosis Study Questionnaire (CaMOS) (Adachi et al., 2001).	A moderate correlation was reported between exercise capacity and BMD (r = 0.42, P = 0.001). Those subjects who had a normal BMD were noted to have a higher exercise capacity than those with osteopenia, and those with osteopenia were noted to have a higher exercise capacity than those with osteoporosis (32.4 (3.0) vs 30.5(1.2) 22.6(3.3) respectively, P = 0.03). There were no correlations between rate of fractures and BMD or exercise capacity.	Strengths: Exercise capacity measurement was objective rather than from patient recall. Limitations: Small sample size, a one-time point assessment without follow-ups which could bring anxiety effects, and lack of an intervention with a control group indicating an association not a cause-and-effect relationship between exercise and BMD.

Table 3: A summary of the studies reviewed through this narrative review

Author and Year of Publication	Title	Study Design and Outcome Measures	Key Findings	Strengths and Limitations
Dodd et al. (2008)	Bone Mineral Density in Cystic Fibrosis: Benefit of Exercise Capacity	A cross-sectional and prospective type of study was conducted. A total of 25 subjects with CF were randomly chosen. Outcome measures: Objective exercise parameters of gas exchange, exercise performance and respiratory mechanics measured by maximal exercise cycle ergometry, BMD of lumbar spine and total proximal femur assessed with DEXA scans, lung function using a spirometer, anthropometric and biochemical measurements.	The results showed a significant correlation between objective exercise parameters and BMD. The strongest correlation was seen between % Peak-predicted Oxygen uptake and BMD (correlation with total proximal femur Z-score, $r = 0.59$, $P < 0.01$; correlation with lumbar spine Z-score, $r = 0.44$, $P < 0.01$). There was a greater correlation between objective exercise measures and BMD of the total proximal femur than with BMD of the lumbar spine.	Strengths: Random allocation of participants and exercise parameters were measured objectively in real time. Limitations: Small number of subjects, a single-day assessment, absence of an intervention, no consideration of factors contributing to low BMD including corticosteroid use and bone turnover, and exercise diaries were not recorded for subjects thus each subject' fitness level may have differed.

Table 3: A summary of the studies reviewed through this narrative review

Author and Year of Publication	Title	Study Design and Outcome Measures	Key Findings	Strengths and Limitations
Garcia et al. (2011)	Bone Health, Daily Physical Activity, and Exercise Tolerance in Patients with Cystic Fibrosis	A cross-sectional and an observational analytic study was conducted in 50 subjects with CF. Outcome measures: Demographic data collection excluding subjects on corticosteroids, BMD measures of lumbar spine, femoral neck and whole body using DEXA scans, record of daily average physical activity (PA) in minutes over 5 days with a portable monitor quantified as low, moderate and vigorous, exercise capacity assessed by a six-minute walk test (6MWT) (ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories, 2002) and cycle ergometry (Ross, 2003) vertebral fractures and deformities radiologic evaluation by the Genant and Cobb methods (Genant et al., 2000)	Daily PA performed at low and moderate intensities showed a positive correlation with BMD of the lumbar spine ($r = 0.36$, $P < 0.01$ and $r = 0.59$, $P < 0.001$), femoral neck ($r = 0.51$, $P < 0.001$ and $r = 0.72$ $P < 0.001$), and total hip ($r = 0.54$, $P < 0.001$ and $r = 0.74$, $P < 0.001$). The correlation between daily PA and BMD in the hip was stronger than in the lumbar spine. Daily PA performed at low, moderate and vigorous intensities demonstrated a positive correlation with exercise capacity assessed using the 6MWT ($r = 0.36$, $P < 0.05$) and during the cycle ergometry ($r = 0.4$, $r=0.38$, and $r=0.42$, respectively; $P < 0.05$). BMD did not correlate with vertebral fractures and kyphosis ($P = 0.35$ and $P = 0.4$, respectively).	Strengths: PA was assessed without the use of questionnaires outside the controlled environment of an exercise laboratory, potential confounding factors increasing the risk for low BMD including the use of corticosteroids were excluded from the study. Limitations: A small number of participants, the cross-sectional design of the study being a short-term study precludes objective observation of fracture incidence in subjects with low BMD, absence of an exercise intervention.

Table 3: A summary of the studies reviewed through this narrative review

Author and Year of Publication	Title	Study Design and Outcome Measures	Key Findings	Strengths and Limitations
Gaowgzeh (2015)	Bone Mineral Status Response to Aerobic Exercises in Asthmatic Patients	A randomised controlled trial. 50 recruited asthmatic patients on long-term high-dosage inhaled corticosteroids were randomly divided into 2 equal groups; one being the active group and the other the control group. The former group received 6 months of progressive aerobic exercise training at a moderate intensity whilst the latter did not receive any structured exercise programme during the duration of the study. Outcome measures: Anthropometric measures at baseline, BMD of lumbar spine and radius assessed with DEXA scanner at baseline and after 6 months for both groups.	At the 6th month, only the exercise group showed significant improvements in lumbar spine BMD (from 120.96 ±9.17 at baseline to 150.32 ±8.37 at month 6, $P < 0.05$) and radius (from 266.62 ±12.37 at baseline to 311.26 ±11.35 at month 6, $P < 0.05$). The control group saw a significant decrease in lumbar spine BMD (from 122.16 ±7.98 at baseline to 120.47 ±7.87 at month 6, $P > 0.05$) and radius (from 268.12 ±10.21 at baseline to 265.96 ±9.73 at month 6, $P > 0.05$). At the 6th month, BMD values at the lumbar spine and radius locations differed significantly between the two groups.	Strengths: Both groups were homogenous regarding their demographic variables at baseline. Randomised allocation of the recruited subjects eliminating potential allocation bias, and the presence of a supervised intervention with a control group ensuring that only the independent variable of exercise caused a change in the dependent variable of BMD. Limitations: A small number of participants.

Table 3: A summary of the studies reviewed through this narrative review

Author and Year of Publication	Title	Study Design and Outcome Measures	Key Findings	Strengths and Limitations
Liu et al. (2015)	Low Bone Mineral Density in COPD Patients with Osteoporosis is Related to Low Daily Physical Activity and High COPD Assessment Test Scores	Cross-sectional study. 30 subjects diagnosed with COPD recruited. Outcome measures: Collection of basic demographic data, lifestyle and disease-related data by a personal interview, BMD of femoral neck, total hip and lumbar spine measured using DEXA scanner, 24hour daily physical activity (PA) measured using an actigraph and oxygen saturation using a pulse oximeter, CAT (Jones et al., 2009) administration, pulmonary function parameters using spirometry, serum samples for laboratory measurements.	No statistically significant differences were observed between pulmonary function parameters of those with and without osteoporosis ($P > 0.05$). Subjects without osteoporosis had statistically significantly greater daily PA (P = 0.0193) counts per minute and lower CAT scores (5.0 ±3.8 vs 8.1 ±5.8, P < 0.05) than those with osteoporosis. BMD values of lumbar spine, total hip and femoral neck were significantly positively correlated with DPA (r=0.399, r=0.602, r=0.438, respectively, all $P < 0.05$). BMD of total hip and femoral neck were significantly negatively correlated with CAT scores (r=-0.412, $P < 0.05$; r=-0.552, P < 0.01, respectively).	Strengths: Revealed a relationship between DPA and BMD in a short period of time. Eliminated the confounding influence of variables including the use of systemic corticosteroids. Limitations: Small sample size, short duration of study not able to investigate long-term effects, no exercise intervention and use of control group to establish a cause – and-effect relationship between exercise and BMD. No consideration of potential underlying comorbidities of COPD including symptoms of GERD, anxiety and depression which may correlate with DPA, BMD and CAT scores.

Table 3: A summary of the studies reviewed through this narrative review

Author and Year of Publication	Title	Study Design and Outcome Measures	Key Findings	Strengths and Limitations
Abd El-Kader et al. (2016)	Aerobic Exercise Training Modulates Bone Mineral Status in Patients with Chronic Obstructive Pulmonary Disease	A randomised controlled trial was designed. 60 patients diagnosed with COPD on high dosage of inhaled corticosteroids were recruited and randomly allocated into 2 equal groups. The active group participated in a 6 – month moderate aerobic exercise programme whilst the control group did not participate in any structured exercise programme for 6 months. Outcome measures (measured for both groups): demographic data, anthropometric measures, clinical history and lung function using spirometry at baseline, BMD measurements of lumbar spine and radius taken with DEXA scanner at baseline and month 6, serum calcium and parathyroid hormone measurements through collection of peripheral blood at baseline and month 6.	Lumbar spine and radius BMD increased significantly in the active group (from 122.16 ±10.54 at baseline to 147.63 ±12.81 at month 6, $P < 0.05$; from 257.13 ±15.72 at baseline to 323.42 ±17.95 at month 6, $P < 0.05$, respectively) whilst decreased non-significantly in the control group after 6 months (from 124.36 ±11.27 at baseline to 122.98 ±11.23 at month 6, $P > 0.05$; from 261.58 ±14.65 at baseline to 257.12 ±14.51 at month 6, $P > 0.05$, respectively). Additionally, at the 6 month, a significant difference was noted between both groups ($P < 0.05$).	Strengths: A randomised block procedure was used to assign subjects into the 2 groups. Baseline characteristics of both groups were similar. Includes supervised intervention with a control group. Both groups were considered homogenous at baseline with regards to their demographic and baseline data. Excluded potential confounding factors including those taking any medication likely to influence BMD. Limitations: Small number of participants.

Table 3: A summary of the studies reviewed through this narrative review

Author and Year of Publication	Title	Study Design and Outcome Measures	Key Findings	Strengths and Limitations
Tejero et al. (2016)	The Role of Daily Physical Activity and Nutritional Status on Bone Turnover in Cystic Fibrosis: a Cross-Sectional Study	Cross-sectional study. 50 people with stable CF were enrolled in this study throughout which 96% of participants received systemic corticosteroids. Outcome measures: Femoral neck, lumbar spine and total body BMD assessed with DEXA scanner, exercise capacity assessed with maximal cardiopulmonary exercise test using a cycle ergometer, 24hr daily PA monitoring for 5 days using a portable device in minutes quantified as MET levels, anthropometric measures, lung function measures, lean muscle mass and fat mass measured with DEXA scanner, biochemical and bone turnover biomarkers assays.	A positive correlation was found between time spent on all levels of daily PA and BMD of at least two different sites. The strongest correlation was seen between daily 'moderate' PA and BMD at the total hip location ($r = 0.74$, $P < 0.001$). The correlation between the amount of time allocated to daily PA at a 'moderate' level and BMD was shown to be stronger than the correlation between the duration of daily PA at a 'vigorous' intensity and BMD in all regions. The time spent on all different intensities of daily PA was found to have a better correlation with hip BMD than the lumbar spine.	Strengths: Physical activity was objectively measured in real time outside of the exercise laboratory. Limitations: Small number of participants, corticosteroid treatment might have acted as a potential confounding factor, duration of study was short with no exercise intervention unable to demonstrate a cause-and-effect relationship between exercise and BMD.

Table 3: A summary of the studies reviewed through this narrative review

Author and Year of Publication	Title	Study Design and Outcome Measures	Key Findings	Strengths and Limitations
Gupta et al. (2019)	Effects of Exercise Intervention Program on Bone Mineral Accretion in Children and Adolescents with Cystic Fibrosis: a Randomized Controlled Trial	A randomised controlled trial in which 52 CF subjects were randomly allocated to exercise and control groups. The exercise group performed a prescribed home exercise programme (HEP) and the control group continued with their usual daily PA level for a period of 1 year. The HEP for the active group included resistance training and a plyometric regime. A 3-monthly (+/ – 2 weeks) follow-up was carried out for both groups for a period of 1 year. Outcome measures (for both groups): Following assessed at baseline and at 1 year: BMD of whole body and lumbar spine using DEXA scanner, anthropometric measures, exercise capacity through maximal exercise testing on a treadmill (Thompson et al., 2010) lung function using spirometry, bone related biochemical parameters, dietary intake assessed with validated 24-hr food recall and semi-quantitative foo frequency questionnaire for sources rich in calcium, quality of life assessed using validated Cystic fibrosis questionnaire-revised (CFQ-R) (Hay, 1995) and habitual activity estimation scale (HAES) used to assess daily physical activity (Kir et al., 2015). Following assessed in every 3 monthly follow-up: Spirometric measurements and compliance assessment for both groups, exercise intensity assessment for the active group. Telephonic guidance and assessment of exercise compliance were carried out every 2 weeks for the intervention group.	All subjects in the active group performed the HEP with an overall compliance of 63%. The change in lumbar spine BMD over 1 year was 0.001g/cm2 (95% Cl – 0.02 to 0.02) higher in active group as compared to control group, although this change was statistically insignificant. The change in whole-body BMD over 1 year of study was 0.006 g/cm2 (95% Cl – 0.04 to 0.03) lower in the active group compared to controls, although this change was also statistically insignificant. No significant difference was noted between the groups' changes in lung function parameters after 1 year. A higher significant positive change in the exercise capacity was noted for the exercise group over the 12-month period.	Strengths: Randomised allocation of participants into groups decreasing potential allocation bias, study being an interventional trial including a control group with similar baseline characteristics for both groups, BMD was performed and analysed by the same blinded technician minimising potential inter-observer variation. Both groups treated identically except for the intervention being tested preventing any potential performance bias, no drop-outs from both groups eliminating attrition bias. Limitations: Small sample size, the intervention was not supervised potentially influencing compliance rates with the exercise programme, follow-ups were not frequent and inclusion of subjects with severe lung disease may have impacted their performance of high impact exercises, possible confounding factors such as corticosteroids use, lack of adherence of vitamin D and calcium supplementation which for both groups might have influenced the relationship between exercise and BMD.

Table 3: A summary of the studies reviewed through this narrative review

Author and Year of Publication	Title	Study Design and Outcome Measures	Key Findings	Strengths and Limitations
Lowder (2021)	Improved Exercise Tolerance and Lung Function in Women with LAM Following Three Months of Exercise Training	A One-Group Pretest-Posttest quasi-experimental type of design was adopted. 8 subjects with lymphangioleiomyomatosis (LAM) were enrolled in the study and participated in a 12-week supervised exercise intervention consisting of treadmill training, aerobic exercise circuits and strength training. Outcome measures: Following assessed at baseline and at week 12: Whole body BMD assessments with DEXA scanner, exercise tolerance with treadmill ergometry, pulmonary function parameters using spirometry.	After 12 weeks of exercise training, subjects experienced a group mean percent improvements in the whole body BMD (from 1.16 g/cm^2 at baseline to 1.178 ±0.12 g/cm^2 at month 3, P = 0.28), in exercise tolerance (VO_2 peak improved by 13.3%, P = 0.06), and in pulmonary function measures; FEV_1 (P = 0.19), FVC (P = 0.085), FEV_1/FVC% (P = 0.38), FEV_1 predicted (P = 0.11) and peak flow (P = 0.19). However, all group mean results were found to be statistically insignificant (P = 0.05).	Strengths: Supervised exercise intervention. Limitations: Small number of subjects, duration of intervention was short, being a quasi-experimental study where randomisation is not used and there is lack of control group for comparison increasing vulnerability to internal validity threats.

Critical Appraisal of Articles

A critical appraisal was conducted to assess the reliability of the included studies by evaluating their methodological quality and potential biases. Each study was examined for risk of bias to ensure transparency in evidence synthesis.

The Cochrane Risk of Bias (RoB2) tool (Flemyng et al., 2023) was used to evaluate three randomised controlled trials (RCT) (Abd El-Kader et al., 2016; Gaowgzeh, 2015; Gupta et al., 2019) **(Table 4).** Risk of bias was assessed across five domains: selection, performance, attrition, detection and reporting.

Table 4: Cochrane Risk of Bias (RoB2) Tool (Flemyng, Moore et al., 2023**)**

Author and Year of Publication	Random sequence generation	Allocation concealment	Blinding participants and personnel	Adherence to intervention	Missing outcome data	Blinding of outcome assessment	Selective reporting	Overall risk of bias
Gaowgzeh (2015)	+*	?†	−‡	?	+	?	+	−
Abd El-Kader et al. (2016)	+	?	−	?	+	?	+	−
Gupta et al. (2019)	+	?	−	−	+	?	+	−

Key

*Low risk of bias †Unclear risk of bias ‡High risk of bias

All the three studies, had a random allocation sequence and both groups were considered homogenous at baseline strengthening internal validity but the concealment of allocation was not detailed; therefore, this aspect of selection bias was evaluated as having an unclear risk of bias. Performance bias was judged as high risk in all 3 RCT studies because participants and personnel were not blinded to the intervention. A RCT by Gupta et al., (Gupta et al., 2019) indicated a 63% overall adherence to the unsupervised exercise programme, leading to the assessment of a high risk of performance bias due to its potential impact on the study's results. Adherence to the exercise programme was not reported in two RCT studies by Abd El-Kader et al., (2016) and Gaowgzeh (2015), leading to an assessment of unclear risk of bias. The risk for attrition bias was determined to be low since there were no missing outcome data in any of the RCTs. Insufficient information was provided in all 3 RCTs with regards to whether outcome assessors were aware of the intervention received. No selective outcome reporting bias was detected, there is clear evidence that all eligible reported results for the outcome measurements align with the intended outcome measurements and analysis. A high overall risk of bias was judged for all 3 RCTs (Abd El-Kader et al., 2016; Gaowgzeh, 2015; Gupta et al., 2019).

Possible biases in the single quasi-experimental study (Lowder 2021) included were recognised via a critical evaluation of this study outlined below utilising the JBI critical appraisal tool (Barker et al., 2024). In this study it was evident that the 'cause' was manipulated prior to the occurrence of the 'effect' which minimised the potential for bias. The lack of a control group jeopardised the validity of the causal inferences. Outcome measurements were gathered prior to and following the implementation of the intervention to investigate the temporal changes in effect within the group. There was no loss to follow-up suggesting no attrition bias. The reliability of the outcome measures and the statistical analysis method were not sufficiently described, resulting in an unclear risk of bias that impacts the reliability and validity of results.

These cross-sectional studies (Dodd et al., 2008; Frangolias et al., 2003; Garcia et al., 2011; Liu et al., 2015; Tejero et al., 2016) were evaluated using the AXIS tool (Table 5). These studies examined relationships between physical activity, exercise capacity and BMD.

Table 5: The AXIS tool (Downes et al., 2016):

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Frangolias et al. (2003)	Y	Y	?	Y	Y	?	?	?	Y	Y	?	?	?	?	?	Y	Y	Y	?	Y
Dodd et al. (2008)	Y	Y	?	Y	Y	?	?	?	Y	Y	?	?	?	?	?	Y	?	Y	?	Y
Garcia et al. (2011)	Y	Y	?	Y	Y	?	?	?	Y	Y	?	?	?	?	?	Y	Y	Y	?	Y
Liu et al. (2015)	Y	Y	?	Y	Y	?	?	?	Y	Y	?	?	?	?	?	Y	Y	Y	?	Y
Tejero et al. (2016)	Y	Y	?	Y	Y	?	?	?	Y	Y	?	?	?	?	?	Y	?	Y	?	Y

Key to the AXIS tool (Downes et al., 2016):

No.	Question	Yes (Y)	No (N)	Don't know/ Comment (?)
1	Were the aims/objectives of the study clear?			
2	Was the study design appropriate for the stated aim(s)?			
3	Was the sample size justified?			
4	Was the target/reference population clearly defined? (Is it clear who the research was about?)			
5	Was the sample frame taken from an appropriate population base so that it closely represented the target/reference population under investigation?			
6	Was the selection process likely to select subjects/participants that were representative of the target/reference population under investigation?			
7	Were measures undertaken to address and categorize non-responders?			

Key to the AXIS tool (Downes et al., 2016):	
8	Were the risk factor and outcome variables measured appropriate to the aims of the study?
9	Were the risk factor and outcome variables measured correctly using instruments/ measurements that had been trialed, piloted or published previously?
10	Is it clear what was used to determined statistical significance and/or precision estimates? (e.g., p values, Cis)
11	Were the methods (including statistical methods) sufficiently described to enable them to be repeated?
12	Were the basic data adequately described?
13	Does the response rate raise concerns about non-response bias?
14	If appropriate, was information about non-responders described?
15	Were the results internally consistent?
16	Were the results for the analyses described in the methods, presented?
17	Were the authors' discussions and conclusions justified by the results?
18	Were the limitations of the study discussed?
19	Were there any funding sources or conflicts of interest that may affect the authors' interpretation of the results?
20	Was ethical approval or consent of participants attained?

A cross-sectional design was found to be appropriate to fulfill the studies' aims/objectives however this design cannot establish causality due to their short duration and lack of intervention or control group. While the researchers explained the process of sample size calculation, the limited number of participants in each study could have resulted in findings that were underpowered and potentially inaccurate leading to potential bias. Randomisation methods were not outlined, possibly resulting in a non-representative sample being selected, consequently influencing the studies' results and leading to an unclear risk of selection bias.

All outcome variables were assessed in alignment with the study's aims and objectives using standardised procedures, like those utilised for the cardiopulmonary exercise test (Ross, 2003), as well as outcome measures that are previously published and validated, such as the Six-Minute Walk Test (6MWT) (ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories, 2002) and COPD Assessment Test (CAT) (Jones et al., 2009). However, it was not clear whether the outcome measures were evaluated by the same or different observers across all subjects, which introduces an unclear risk of inter-observer reliability bias. The researchers provided a clear description of the statistical analysis that enabled repeatability in three studies.

Nevertheless, Dodd et al (Dodd et al., 2008) and Tejero et al (Tejero et al., 2016), overlooked the confounding factors associated with low BMD in both the analysis and the interpretation of results, even though this was outlined in the limitations of their studies.

Discussion

This review highlights the positive effects of exercise training on bone mineral density (BMD) in patients with COPD and other pulmonary conditions. Improvements in BMD are attributed to mechanical loading during exercise which stimulates the Wnt3a/β-catenin signaling pathway, enhancing osteoblast differentiation and bone formation. Additionally, exercise-induced acidosis leads to an increase in serum calcium levels which reduces secretion of parathyroid hormone by the parathyroid gland, and contributing to BMD improvement (Chen et al., 2021; Grimston et al., 1993).

Reduced physical activity in COPD patients is associated with a sedentary lifestyle, disease severity and exertional dyspnoea, perpetuating a cycle of inactivity, muscle weakness and BMD loss (De Kam et al., 2009; Katajisto et al., 2012; Robinson et al., 2018; Vrieze et al., 2007). Exercise training improves oxygen transport, muscle strength, and cardiorespiratory fitness, positively impacting exercise capacity and pulmonary function (Farrell & Turgeon, 2023; Liu et al., 2015).

However, this review found insufficient evidence on the effects of exercise on fall and fracture risks due to the limited duration of observational studies. Improved BMD and functional capacity can reduce these risks, but further research is needed to explore this relationship.

Conclusions and Areas of Future Research

Exercise training shows potential for improving BMD in patients with COPD, though evidence remains limited and subject to bias. Future research should focus on long term randomised controlled trials assessing the effects of PR on BMD, fall and fracture risks and functional exercise capacity. Such studies will help develop targeted interventions to prevent adverse outcomes and enhance the quality of life for COPD patients.

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Research Paper

The Effect of External Beam Radiotherapy on the Quality of Life of Head and Neck Cancer Patients in Malta

Clara Francesca Aquilina
Department of Radiography, Faculty of Health Sciences, University of Malta, Msida, Malta.
Gerrit Albertus van Dijk
Department of Radiography, Faculty of Health Sciences, University of Malta, Msida, Malta.
Kristina Caruana
Radiotherapy Department, Sir Anthony Mamo Oncology Centre, Msida, Malta.
Kristin Caruso
Mater Dei Hospital, Msida, Malta.
Michela Mallia
Mater Dei Hospital, Msida, Malta.
Liberato Camilleri
Department of Statistics & Operations Research, Faculty of Science, University of Malta, Msida, Malta.

Abstract

Globally, patients undergoing head and neck (HN) external beam radiotherapy (EBRT) experience debilitating side effects, which often result in a diminished quality of life (QoL). This study was conducted in Malta, and it aimed to highlight which QoL domains are mostly affected by EBRT to the HN, and whether or not the extent of the QoL decline is affected by demographic factors. A quantitative, non-experimental, analytic, longitudinal and prospective design was conducted with 17 participants undergoing HN EBRT. Participants completed the European Organisation for Research and Treatment of Cancer (EORTC) QLQ-C30 and EORTC QLQ HN43 questionnaires during the first and last weeks of treatment. Additionally, demographic data were collected through a set of 12 questions in the first phase of the study. Out of the 17 patients that were approached, only 11 completed the questionnaires. Seven participants reported a decrease in overall QoL, especially in the emotional domain. Treatment types and combinations had a significant impact on QoL, with those receiving combined therapies showing the most significant changes. However, 3 participants reported no decline in QoL, particularly those who had localized treatment without lymph node (LN) involvement. Gender and age did not seem to affect QoL among the participants. This study indicates that patients with HN cancer experience a deterioration in their overall QoL from the beginning to the end of EBRT. The extent of this decline is influenced by clinical variables, such as treatment site and type of treatment prescribed. Holistic support needs to be given to HN cancer patients undergoing EBRT, so as to target all the QoL domains that are affected by HN EBRT.

Keywords: External beam radiotherapy, Head and neck cancer, Quality of life, Demographic factors, Side effects

Correspondence to Clara Francesca Aquilina
Email: clara.aquilina.14@um.edu.mt
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Introduction

QoL is a multidimensional concept encompassing physical, mental, emotional, and social functioning (Sharma, Mishra & Parikh, 2019). Head and neck (HN) cancer patients experience decreased QoL following EBRT (Niska et al., 2020), and this significantly impacts their prognosis (Kutz et al., 2022).

The study assessed the QoL of HN patients in Malta during the first and last week of EBRT treatment. The objectives of this study include assessing the overall QoL at the beginning of EBRT to the HN, evaluating changes at the end, identifying affected QoL domains, and comparing QoL change to demographics and clinical variables.

Literature Review

HN cancer refers to tumours of the HN region, such as the thyroid gland, nasal cavities, oral cavity, larynx, paranasal sinuses, salivary glands, pharynx and oesophagus. Tumours of the face, neck, base of the skull, ear and orbit are also considered as HN cancer. Tumours of the HN region are the 10th most common cancers in the world. Social behaviours, including drinking alcohol and smoking tobacco, have been identified as the primary risk factors for HN cancer development (Onakoya et al., 2006). Treatment options for HN cancer include surgery, radiotherapy, chemotherapy and/or a combination of two or more of these treatment options.

Treatment options impact the QoL of HN cancer patients significantly with patients receiving intensity-modulated radiation therapy (IMRT) for HN cancer having higher overall and cancer-specific QoL compared to those receiving chemoradiotherapy (CRT) (Tribius et al., 2018). In fact, it has been found to cause unwanted side effects like oral pain, decreased appetite, dysphagia, dry mouth, fatigue, and hoarseness (Smith & Lewin, 2010), even though it is said to be the gold standard for various cancers (Lee et al., 2021). These effects negatively impact patients' QoL in the HN region, leading to a worse prognosis. The World Health Organization (WHO) defines QoL as an individual's perception of their position in life, encompassing physical health, psychological state, independence, social relationships, personal beliefs, and environmental features.

Other demographic factors such as treatment site, gender, age, social status, ethnicity, and marital status may also impact the QoL of HN cancer patients (Orindi, (Orindi et al., 2021). In fact, some studies suggest that younger patients may show a significant decline in the social domain, while older patients tend to show a greater decline in the physical domain (Sharma, Mishra & Parikh, 2019). Consequently, the observed differences between studies may suggest that QoL impact is population-specific, emphasising the importance of studying the QoL of the specific population of HN patients undergoing EBRT in Malta. Treatment site significantly impacts the QoL of HN cancer patients, with oral cavity cancer diagnosis being a predictor of poor QoL. Patients with larynx and hypopharynx tumours experience speech difficulties and difficulty opening the mouth, negatively impacting QoL (Wells et al., 2016).

Patients with a low socioeconomic status (SES) report worse QoL scores after EBRT treatment in the HN region due to higher alcohol consumption, tobacco smoking, alcohol withdrawal, retirement, and widowhood or divorce, which may contribute to their overall worse QoL scores (Tribius et al., 2018). Ethnicity also plays a significant role in the QoL of Hispanic and Black non-Hispanic HN cancer patients. Studies show that black Hispanic and black non-Hispanic patients have poorer survival rates than white patients due to delayed diagnosis and less treatment (Baliga et al., 2023). Modifiable risk factors include strengthening preventative programs, increasing access to non-emergent healthcare, and providing more navigational assistance (Slater, 2020). Late diagnosis can lead to worse fatigue and constipation scores, affecting the QoL of HN cancer patients (Schoonbeek et al., 2022). However, these studies have limitations, such as selection bias and inaccessible cancer-specific mortality data.

Methods

The research design used in this study was a quantitative, non-experimental, analytic, longitudinal, and prospective design. A quantitative study was chosen to measure and evaluate outcomes and determine the QoL domains most affected by EBRT. The study used closed-ended questionnaires, which were inexpensive, timely, and maintained patient privacy, to gather data and understand the effects of EBRT on the QoL of HN cancer patients.

Target Population

The research targeted all patients receiving EBRT treatment in Malta's sole oncology hospital, specifically those in the HN region, but due to time constraints, data

was collected from a representative sample available during November 2023 to March 2024.

The study intermediary invited all of the participants starting HN EBRT between November 2023 and March 2024. Participants were given the EORTC QLQ-C30 (Aaronson et al., 1993) and EORTC QLQ-H&N43 (Singer et al., 2015) twice, once in the first week of the HN EBRT treatment and another time in the last week of their HN EBRT treatment. The intermediary distributed questionnaires in either English or Maltese, according to the patient's language preference. Prior to distributing the questionnaires, the intermediary marked the questionnaires with a specific code, which was then recorded in a sheet that could only be accessed by the intermediary. Each participant had a unique code, this enabled the researcher to identify which phase 1 and phase 2 questionnaires belong to a specific patient.

The participants were given a week to fill in and post the questionnaires, this increased the probability of participation and it also made it more possible for the patients to answer accurately. Since, the participants could take the questionnaires home and answer the questions at a time that was most convenient to them.

Inclusion Criteria

The study included patients aged 18 or older, who could read and write in English or Maltese, and who started EBRT treatment in the HN region. Palliative patients were excluded, since this population may have different QoL needs, and these need to be studied separately (Islam et al., 2023).

The EORTC QLQ-C30 questionnaire, used since 1993, has been tested for reliability and validity in various settings, including breast, lung, and HN patients. Cronbach's Alpha was used to assess reliability, with all scales having a Cronbach's coefficient of 0.6 or greater. The EORTC QLQ-HN43 questionnaire also showed high reliability, with Cronbach's Alpha values of over 0.70 in 10 of the 12 multi-item scales. The validity of the EORTC QLQ-C30 and EORTC QLQ-HN43 questionnaires has also been tested.

Data Analysis

The data was analysed using Statistical Package for Social Sciences (SPSS) version 26 software. The Paired Samples T-Test was used to test the significant differences between the means of two paired measures. Given the small sample size (n=11), formally testing the normality of the difference scores was not feasible. Therefore, normality was assumed for the purpose of the analysis. The Paired Samples T-Test was selected as it is a widely recognised and commonly used method for comparing mean differences between two related groups. This test was deemed appropriate given the primary aim of the study, which was to assess whether there was a statistically significant change in QoL following EBRT. Furthermore, the Paired Samples T-Test is considered relatively robust to moderate violations of the normality assumption, particularly in studies with small sample sizes (Lumley et al.,). In light of these considerations, the decision was made to proceed with the Paired Samples T-Test.

The Paired Samples T-Test was also used to compare the mean severity and QoL ratings between the first and last weeks of EBRT. The mean severity rating scores ranged from 1 to 4, with a p-value smaller than 0.05 indicating significant variation between the two phases. The mean QoL rating scores ranged from 1 to 7, with a p-value smaller than 0.05 indicating significant variation, and a p-value greater than 0.05 indicating marginal variation.

Ethical Considerations

The study (FHS-2023–00180) was reviewed and approved by a local ethics committee, and the recruitment process was done by an intermediary, which was a therapeutic radiographer working at the state oncology hospital. The intermediary was key to ensure the anonymity of patients and to ensuring that there was absolutely no risk of coercion of patients.

The patient information sheet (PIS) explained that participation in the study is interpreted as consent. Additionally, the PIS explained clearly that participation is voluntary and that no repercussions will result should participation be refused. Furthermore, the PIS stated that the data collected would be used solely for this research and will be destroyed at the conclusion of the study. The data acquired was kept under lock and key in a drawer accessible only to the researcher, and in the case of digital results, in a password-secured computer.

Results

Out of the 17 patients that were approached, 11 patients returned the questionnaires of both phases, giving a response rate of 64.7%. Of the 6 participants who had to be excluded from the study, 4 only filled in the questionnaires of phase 1, so they could not be considered in the study; the other 2 participants refused to take part because they could not read and write.

The 11 participants who took part in this study comprised 7 (63.64%) male and 4 (36.36%) female respondents. The ages of the participants ranged from 45 to 84 years. Respondents also differed in terms of the treatment site, treatment prescribed, LN treatment, and tumour-node-metastases (TNM) staging. Table 1 and Table 2 summarise the patients' characteristics.

In this study, the majority of participants (36.36%, n=4) rated their QoL as above average, while 27.27% (n=3) rated it as average. Only 18.18% (n=2) rated it as good, and only 9.09% (n=1) rated it as below average. Similarly, only one (9.09%) of the participants rated their overall QoL as 'excellent' at the beginning of the treatment. These results were achieved by using a mean QoL rating score which ranged from 1 to 7, where 1 corresponds to 'very poor' and 7 corresponds to 'excellent'. The study highlights the importance of evaluating overall QoL at the start of EBRT, as it varies greatly among patients.

The study showed that there is a significant change in the QoL at the end of EBRT to the HN (Figure 1). In fact, seven (63.64%) out of the eleven patients that participated in this study, reported a decrease in their overall QoL from the first week of EBRT to the HN region to the last week of EBRT to the HN region.

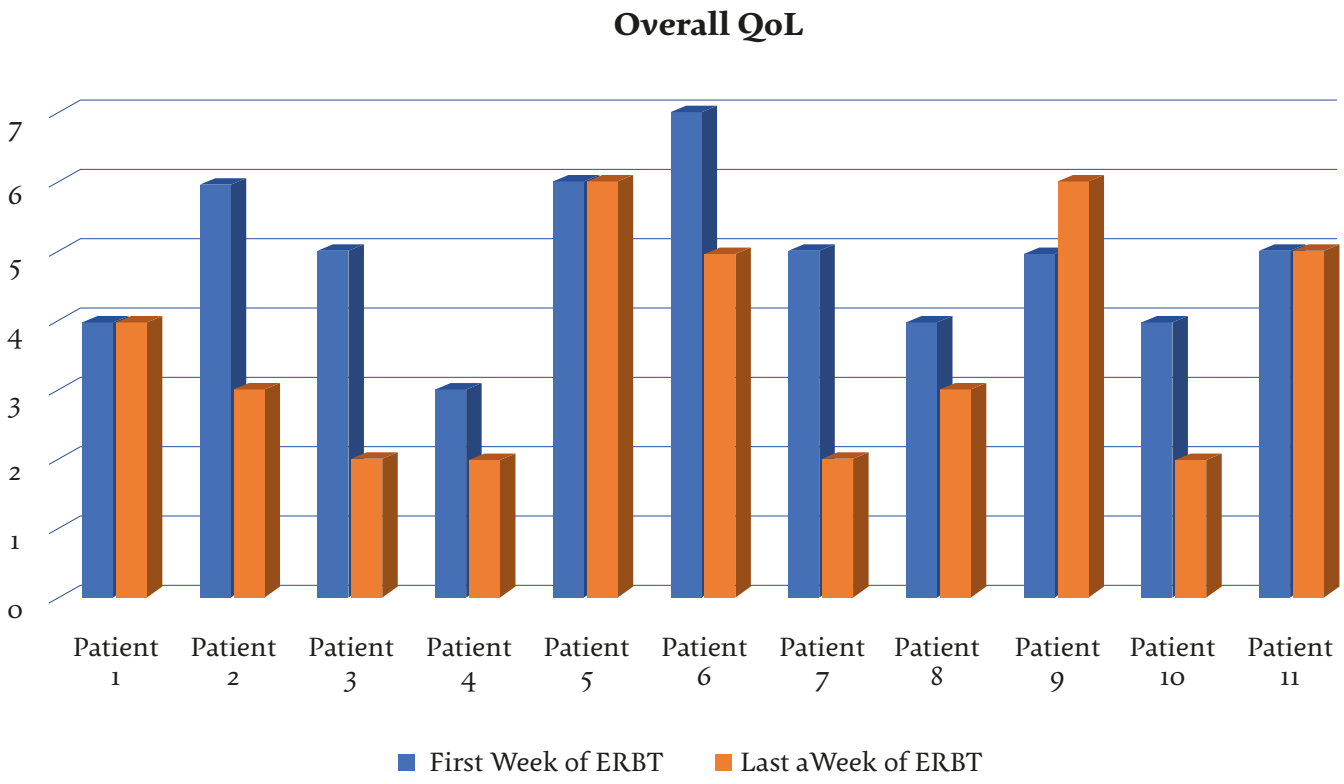

Figure 1: Histogram of Overall QoL Pre-/Post-EBRT

The results obtained in this study show that EBRT to the HN affects all the QoL domains. These include: the physical domain, the mental domain, the emotional domain, and the social domain. However, the QoL domain that is impacted the most by EBRT to the HN is the emotional domain, since, data analysis revealed that the patients felt more tense (p = 0.001), worried (p=0.001), and irritable (p=0.007) in the last week of their HN EBRT relative to the first week

Table 1: Table Showing the Treatment Site, LN Treatment, TNM Staging, & Prescribed Treatment for Patient 1 to Patient 6

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
Treatment Site	Right & left nasal cavity Non-keratinising nasopharyngeal squamous cell carcinoma (SCC)	Oropharyngeal SCC	Tongue	Nasopharyngeal carcinoma	Mucosa, right lateral border of tongue, with metastasis to neck	Right Tongue SCC, RT to oral cavity & right neck
LN Treatment	Yes	No	Yes	Yes	Yes	Yes
TNM Staging	T2 N1 M0	T1 NX MX	pT3 N2a M0	T3 N1 M0	pT3 N2b	pT2 N1 M0
Prescribed Treatment	Concurrent chemotherapy	RT only	Neo-adjuvant surgery Concurrent chemotherapy	Adjuvant chemotherapy Concurrent chemotherapy	Concurrent chemotherapy	RT only
LN Treatment	Yes	No	Yes	Yes	Yes	Yes
TNM Staging	T2 N1 M0	T1 NX MX	pT3 N2a M0	T3 N1 M0	pT3 N2b	pT2 N1 M0
Prescribed Treatment	Concurrent chemotherapy	RT only	Neo-adjuvant surgery Concurrent chemotherapy	Adjuvant chemotherapy Concurrent chemotherapy	Concurrent chemotherapy	RT only

Table 2: Table Showing the Treatment Site, LN Treatment, TNM Staging, & Prescribed Treatment for Patient 7 to Patient 11

	Patient 7	Patient 8	Patient 9	Patient 10	Patient 11
Treatment Site	Tongue	Nasopharynx	SCC left side tongue	Larynx	Buccal mucosa SCC
LN Treatment	Yes	Yes	Yes	No	Yes
TNM Staging	Not available	T1 N1 (stage III)	Not available	Not available	cT4NXM0
Prescribed Treatment	Neo-adjuvant chemotherapy Concurrent chemotherapy	Neo-adjuvant chemotherapy Concurrent chemotherapy	RT only	RT only	RT only

Although the treatment site and treatment options were not statistically analysed, this study suggests they may influence the QoL changes associated with EBRT to the head and neck. Notably, two patients who received EBRT as their sole treatment reported no change in overall QoL. One of these cases involved the larynx/hypopharynx without LN treatment, while the other was an oral cavity case that included LN treatment

No statistically significant findings could be made in relation to age, social status, gender, and marital status. Therefore, not conclusion could be drawn on whether or not these demographic factors influence the QoL changes caused by EBRT to the HN. Possibly because the sample size of this study was too small.

Discussion

A decrease in QoL following EBRT to the HN was reported in 7 patients (63.64%), 5 of whom were prescribed LN treatment. Similar findings have been reported in other studies, which may indicate that LN treatment may have worsened QoL due to lymphoedema and/or larger treatment volumes used for EBRT (Smith & Lewin, 2010; Balbinot et al., 2022). The same 7 participants who were prescribed LN treatment in this study also received concurrent chemotherapy and/or neo-adjuvant surgery, which could have further impacted their QoL.

The study assessed the QoL of HN cancer patients in the first and final weeks of EBRT, indicating that the decline in QoL could worsen, since the peak side-effects occur two weeks after the last radiation treatment. However, 27.27% (n=3) of the 11 patients reported no change in overall QoL, possibly due to not being prescribed surgery. EBRT side effects may continue for up to two weeks after treatment, potentially causing a decline in overall QoL after the end of the study (Macmillan Cancer Support's Cancer Information Development, 2022). On the other hand, 1 patient (9.09%) experienced an increase in overall QoL after EBRT treatment for the left side of the tongue, possibly due to the small treatment area and symptom control achieved through EBRT.

The study found that participants receiving HN EBRT experienced more difficulty in strenuous activities and walking in the last week compared to the first week. This may be due to fatigue, which is a known acute side effect of EBRT (Niska et al., 2020). This study found that the difference in the severity rating scores was significant, this parallels the finding of another study that reported a significant negative relationship between symptoms score and global health and function scores, indicating that patients completing EBRT experience lower functioning and worse global health (Azzopardi, 2023).

The study also found that HN EBRT affects patients' mental and emotional domains, with patients feeling more tense, worried, and irritable in the last week compared to the first week. The differences in these domains were statistically significant ($p<0.05$). This is also confirmed in the findings of another study, which outlined that depression during therapy is a significant cause of mental stress in Nigerian HN patients (Onakoya et al., 2006).

This shows that despite the differences in populations between these two studies, some patterns are similar. However, the study's findings should be considered with caution, due to the different ethnicities of the participants, different timings of assessments, and different patient populations included (Onakoya et al., 2006).

In another study conducted by Sharma et al. (2019), a significant statistical relationship between EBRT phase and the social domain was found. Patients reported more interference with family life and social activities in the last week of treatment compared to the first week. Younger participants, aged 25-50, displayed a decline in the social domain, possibly due to lessening social obligations. No conclusion, however, could be drawn on younger participants (Sharma, Mishra & Parikh, 2019).

This study found that the treatment site affects the QoL of patients treated with EBRT in the HN region. In fact, all 5 (45.45%) patients who were being treated in the tongue reported a significant decrease in their overall QoL from the first week of EBRT to the last week of EBRT. This could be due to greater treatment-induced side effects in tongue cases compared to other treatment sites (Balbinot et al., 2022). This finding could have also resulted from the fact that almost half of the participants taking part in this study were being treated in the tongue. Nonetheless, in this study, no test was carried out to determine whether there was a statistically significant difference in the QoL changes between tongue and non-tongue patients.

The Paired Samples T-Test was used to compare overall QoL in the first week of HN EBRT with the last week, identifying the treatment site with the highest QoL decline. These findings could have resulted from the fact that tongue cases may suffer from greater treatment-induced side effects when compared to the other

treatment sites (e.g. larynx) included within this study (Balbinot et al., 2022). RT, chemotherapy, and significant surgical treatments – with or without reconstruction – have a major negative cosmetic and emotional effect on patients with tongue cancer and can result in functional problems, chiefly dysphagia (Balbinot et al., 2022).

This study also shows that the QoL change from EBRT in the HN region is influenced by treatment options. Two patients who received EBRT as their sole treatment reported no change in overall QoL from the first to last week. The unaffected QoL of patients treated for larynx/ hypopharynx may be due to a small treatment volume, resulting in less side effects (Ozyigit & Chao, 2002). Oral cancer patients often experience concerns about their condition, eating, and social contacts (Chaturvedi et al., 1996).

The greatest overall QoL change was observed in patients receiving EBRT with chemotherapy or surgery, with both experiencing an equal decline from the first week to the last week. Patients prescribed surgery, EBRT, and chemotherapy reported a lesser decline in overall QoL compared to those prescribed EBRT and chemotherapy or EBRT and surgery. This unexpected result may may be due to a small sample size, therefore, more research is recommended.

The study found that 27.27% (n=3) of respondents did not experience a change in their overall QoL from the first week to the last week of EBRT. Two of these three participants were males and one was female. Therefore, this finding could possibly be influenced by gender differences in self-reporting (Shi et al., 2021). However, the relationship between gender differences and the lack of change in the QoL remains unclear in this study.

Conclusion

The study shows EBRT to the HN affects all the QoL domains. Though the QoL domain that is impacted the most by EBRT to the HN is the emotional domain. This highlights the need for holistic support from all the multidisciplinary team (MDT) members, ensuring holistic care throughout treatment, addressing all QoL domains impacted by EBRT.

This study also showed that the treatment site also impacts the QoL of HN cancer patients receiving EBRT. Since all the 5 (45.45%) patients that were being treated in the tongue reported a significant decrease in their overall QoL from the first week of EBRT to the last week of EBRT.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work, the authors used *QuillBot* in order to summarise/ paraphrase. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Commentary

An introduction to Dark Field CT (DFCT): A game changer for the future of CT?

Andrea Bellizzi
Department of Radiography, Faculty of Health Sciences, University of Malta, Msida, Malta.
Francis Zarb
Department of Radiography, Faculty of Health Sciences, University of Malta, Msida, Malta.

Abstract

Computed tomography (CT) technology has undergone rapid evolution in recent years. The introduction of photon-counting CT has already begun reshaping the fundamental principles of CT imaging. In this context of innovation, dark-field CT (DFCT) is emerging as a promising advancement, offering a new imaging contrast based on small-angle X-ray scattering rather than traditional attenuation. This article aims to explore the potential role of DFCT in medical imaging, reviewing the current state of the technology, its underlying physical principles, and the advantages demonstrated in preclinical studies, particularly in detecting microstructural changes in tissues such as the lungs and bones. Although still in the experimental phase, DFCT represents a novel and potentially transformative tool that could complement conventional CT and expand diagnostic capabilities in the future.

Keywords: Computed Tomography (CT), Dark-field CT, Phase contrast CT, Image optimisation.

Correspondence to Andrea Bellizzi
Email: andrea.bellizzi.15@um.edu.mt
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Introduction

Dark-field Computed Tomography (DFCT) is an emerging imaging technique that may soon enter clinical practice. Conventional CT creates images by sending X-rays through the body and measuring how different tissues absorb or block them (attenuation), producing an image based on variations in tissue density (Hermena & Young, 2022). In DFCT, the focus shifts from traditional attenuation-based imaging to the scattering properties of tissues, with particular emphasis on small-angle scattering, which forms the basis of the dark-field signal. In simple terms, scatter happens when X-rays hit tiny structures in the body and bounce off in different directions, rather than passing straight through, helping reveal details that attenuation alone might miss. This technique makes use of the angles at which the X-ray photons scatter when they interact with fine structures; these angles are usually quite small, meaning that the scattered photons deviate only slightly from the direction of the incident beam, hence the term 'small angle scattering' (Viermetz et al., 2022). Small-angle scattering is targeted because it reveals fine structural details that traditional X-ray methods, which depend on large density differences, often overlook. Furthermore, with this method, more fine detail is detected, and fine structures can be visualised more accurately (Rischewski et al., 2024).

The term 'dark-field' is attributed to this technique due to the resultant dark background, and the bright features created by angular scattering, which is opposed to what we are used to visualising with attenuation based CT (Viermetz et al., 2022). A higher intrinsic contrast is

the main benefit of this technique, since the differences in angular deviation of the incident beam, also known as phase contrast, are greater than their attenuation differences. In conventional imaging methods, contrast arises mainly from how much the X-ray beam is absorbed or blocked by tissues, which depends largely on differences in density.

Worldwide, clinical experimentation using DFCT is still not possible due to the lack of clinically approved dark-field CT scanners. The technology remains in the research and development stage, requiring further optimisation and regulatory approval before it can be introduced into clinical practice. As a result, clinical DFCT images are still not available. However, when asking AI DALL-E model ChatGPT 4.0 (*ChatGPT,* 2024) source to predict and create the difference in imaging between the two techniques the images shown in Figure 1 were generated:

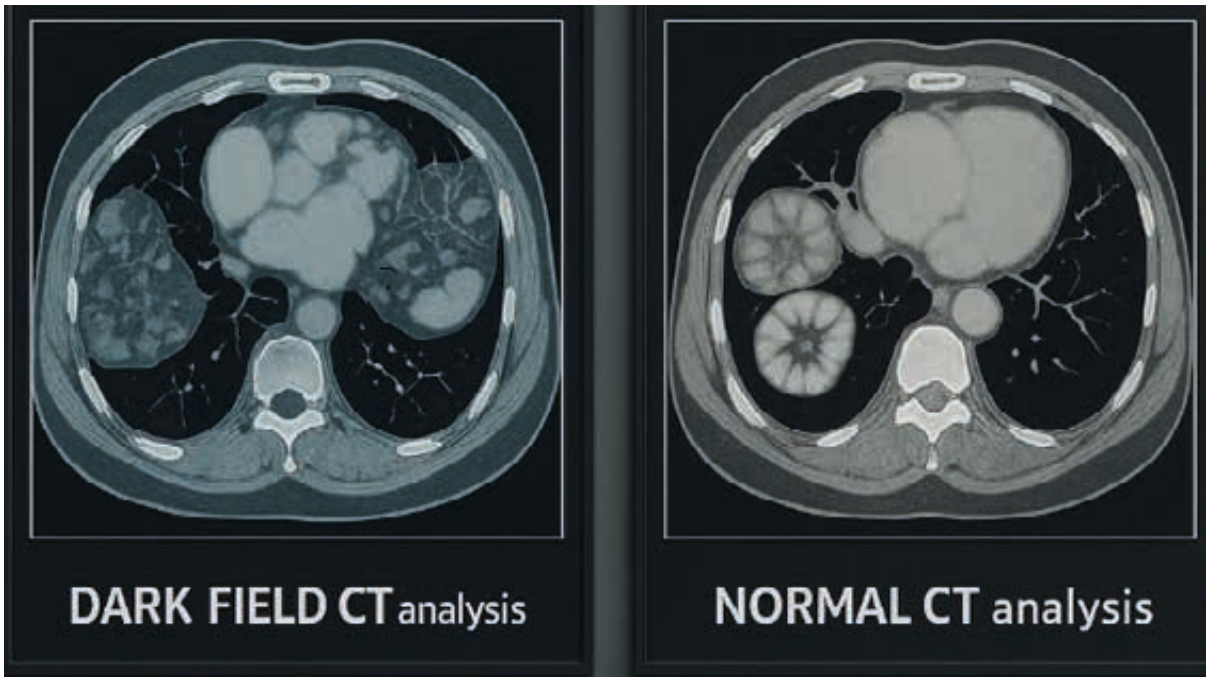

Figure 1: A creation by DALL-E from ChatGPT, showing a prediction of how DFCT (left) would look when compared to conventional CT (right). The DFCT shows finer lung markings, clearer differentiation between cortical and trabecular bone in the vertebral body, and sharper delineation of paraspinal muscles and other soft tissues.

Potential clinical benefits of DFCT

The application of DFCT could highly improve the visualisation of fine structures in the body. In fact, the application of DFCT is being predicted to be beneficial when imaging for specific pathologies of the lung, musculoskeletal system and breast areas (Frank et al., 2022; Wang, 2024). Especially for CT lung, DFCT may offer higher sensitivity in detecting early-stage lung diseases, such as pulmonary fibrosis, emphysema, and small airway disease, which often present with microstructural changes not easily visualised on conventional CT (Frank et al., 2022; Wang, 2024). While preliminary studies suggest improved tissue characterization and functional imaging capabilities with DFCT, quantitative data directly comparing its sensitivity to conventional CT in early disease detection remain limited. Further clinical studies are needed to establish the extent of sensitivity improvement and its potential impact on diagnosis and patient management.

DFCT may also improve visualisation of small structures within the musculoskeletal structure aiding to detect microfractures (Rischewski et al., 2024), while showing promise as a tool that could aid in the early detection of breast cancer and to reduce false positives associated with mammography (Anton et al., 2013). DFCT may also be of use in CT brain imaging by visualising smaller scale tissue changes, therefore leading to the

early detection of neurodegenerative diseases (Viermetz et al., 2022).

Apart from potential benefits in image quality, DFCT might come at no extra cost in terms of radiation dose to the patient. The principle of DFCT uses the same amount of X-ray photons as in a conventional CT scan, simply collecting more information by measuring scattered X-rays in addition to the absorbed ones. This means that, theoretically, DFCT should not require any increase in radiation dose. However, to date, clinical studies directly comparing radiation dose and image quality between DFCT and standard helical (spiral) or multi-slice CT scanners have yet to be conducted, as this technology remains in the early stages of development.

Methods of application and limitations of DFCT

Since this is an emerging technique that makes use of a new principle when compared to the conventional X-ray attenuation detection, new methods of how to combine this technique with the already available CT systems need to be found.

The most promising technology up till now was the use of a grating interferometer (Viermetz et al., 2022). A grating interferometer is an optical tool which acts as a filter and splits X-rays into different pathways. In DFCT, the interferometer uses the wave nature of X-rays to create interference patterns that can be used to detect small-angle scattering (Figure 2).

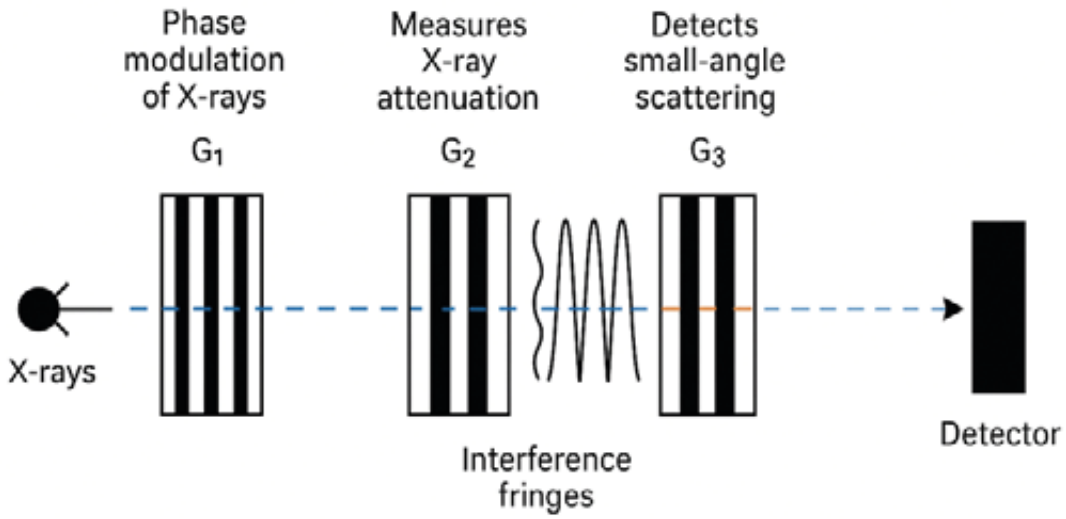

Figure 2: Simplified grating interferometer set-up in DFCT (adapted from Neuwirth et al., 2020).

The interferometer uses three levels of grating or pathways (Pfeiffer, Weitkamp & David, 2006; Miao, Williams & Josell, 2024). The first level is phase grating, where the phase of the x-rays is modulated. This is followed by absorption grating, during which the traditional X-ray attenuation is measured. Finally, dark field grating occurs, where the scattering of the X-ray beam at small angles is detected. The grating interacts with the scattered X-rays to create an interference. This interference produces the resultant images (Pfeiffer et al., 2006; Miao et al., 2024).

This approach was first applied in practice by Viermetz et al. (2022) who successfully integrated the interferometer into a clinical CT gantry. The authors acknowledged the limitation of using a phantom to perform the required tests, however, their results still showcase an important milestone in the application of DFCT.

Frank et al. (2022) applied this concept in clinical practice by using the grating interferometer on planar chest X-ray imaging. The authors found that DFCT can be complementary to conventional planar radiography of the chest, and improves the visualisation and detection of COVID-19 pneumonia. In fact, in a clinical study of 100 patients, the overall sensitivity for detecting COVID-19 pneumonia was 0.43 (95% CI: 0.38–0.48) using attenuation-based images, compared with 0.86 (95% CI: 0.80–0.92) using dark-field images. Taking it one

step further, Gassert et al. (2022) used a murine model to test the application of DFCT in mice. Their study demonstrated that DFCT can detect radiation-induced lung injury from an earlier stage when compared to conventional CT. Moreover, the sensitivity to lung fibrosis was 37% for conventional CT when compared to the 53% of DFCT. Furthermore, in another murine model study performed by Guo et al. (2024) DFCT was found to improve lung nodule detection when compared to conventional CT (p= 0.025). While both studies provided good results, the authors of both studies acknowledged limitations related to field of view, vibration artefacts and image reconstruction techniques, and stated that the development of these areas is essential for the clinical implementation of DFCT.

With regards to the field of view, DFCT uses the gratings, which are very fine tools that must be carefully aligned, and which can only scan a small area in a particular instance, meaning that the CT scanner can only capture a small region of interest at a time (Viermetz et al., 2022). Therefore, further developments in DFCT technology are needed to be able to capture larger areas or structures within the body, the latter issue still being a challenge with current CT scanner designs.

Furthermore, the gratings need to be arranged precisely over the full field of view, making them sensitive to drifts and vibrations (Viermetz et al., 2022). This poses quite a challenge, since a conventional CT system produces drifts and vibrations consistently due to the rotating components which are needed to dissipate heat and to produce the resultant image.

The resultant images produced by a DFCT scanner are not the same as those generated by conventional attenuation-based CT scanners, and hence require different reconstruction algorithms and specialised training for the reporting radiologists, who need to learn a new method of image interpretation. In addition, the structural amendments that need to be performed to a conventional CT scanner and the application of the grating interferometer, increase the costs for any interested vendors of producing a DFCT.

Conclusion

In recent years, CT manufacturers have focused on developing faster scanners, and with the advent of multi-detector CT, extremely rapid scanning times were achieved. Following these advancements in speed, attention shifted toward improving image quality, leading to the growing adoption of technologies such as dual-energy and photon-counting CT (Bellizzi et al., 2025). Building on these remarkable developments, this article explored the potential integration of dark-field CT into clinical practice. While DFCT is still in the experimental stage, ongoing research suggests that it may offer significant diagnostic benefits, particularly in detecting microstructural changes that conventional CT cannot resolve. With continued technological refinement and clinical validation, DFCT has the potential to become a valuable complement to current imaging techniques, rather than remaining a purely theoretical concept.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT to create a prediction of how DFCT would look like when compared to conventional CT if fully applied clinically. After using this service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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PG Oration

Postgraduate Graduation Ceremony Oration, March 2025

Oration by Professor Cynthia Formosa
Ph.D (UK), M.Sc.Pod.(UK), D.Pod., S.R.Pod., FFPM, RCPS(Glasg), ABPMi (US)

'Life can only be understood backwards,
but it must be lived forwards"
~ Soren Kierkegaard

Hon. Minister, Chancellor, Rector, Registrar, Distinguished Guests, Fellow Members of the Academic Body, Graduands, Ladies and Gentlemen.

It is indeed a privilege for me to deliver today's oration as a testimony of the graduands' academic achievements that demonstrate understanding, mastery, talent, engagement and accomplishments. It is an occasion to celebrate the attainment of their academic status achieved through hard work and endless efforts endured during a period of intense studies at our *alma mater,* which saw its origin in 1769 as the *Collegium Melitense,* renamed as the Royal University of Malta in 1947.

I must admit that writing this oration proved to be more challenging than writing the number of publications which I have published to date! But I took up the challenge because I am a person who does not know how to lose out on any opportunity, even if it looks difficult and challenging.

We have gathered here today to celebrate your hard work, but most importantly, to celebrate your achievement. Academic studies are the fundamental aspects of education which lead to intellectual growth, personal development, career advancement and enhanced self-confidence. Tertiary education plays a pivotal role in shaping our societies and has a pronounced impact on economic growth and stability. It facilitates and adds value to the graduand's contribution to society. It is the gateway to better job opportunities that pay well, increasing the overall economic productivity and consumer spending. Professionals with advanced health degrees contribute to better healthcare practices, policies, and community health programs. The direct outcome is a healthier population that reduces the burden on healthcare systems and public resources. Higher education also strengthens society by contributing towards a just and fair environment. It cultivates informed citizens who are more likely to engage in civic and political activities. It is also the backbone of innovation and technological advancements. It is recognised that education is one of the most powerful tools for reducing poverty and social inequality. High learning is not just an individual aspiration but a valuable contribution to the collective strength and advancement of society.

In the ever-changing world of healthcare, professionals are expected to stay updated with the latest research, methodologies, and best practices. This university, with its high reputation, has now equipped you with the skills to conduct research diligently. You now understand that whatever we do needs to be evidence-based, as was postulated by the great philosopher Aristotle. His teachings of logic and philosophy have been a driving force, continuously guiding medicine away from superstition and towards the scientific method. Today, the revival of evidence-based medicine is only a reaffirmation of his early teachings dating from the fourth century BC. The importance of continued education cannot be underestimated. Personal and professional development helps manage your own learning and growth throughout your career. Continuous learning also helps open up new

Correspondence to Cynthia Formosa
cynthia.formosa@um.edu.mt
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doors in your career, keep your skills and knowledge up to date and ensure you practice safely and legally.

Now it is your turn and responsibility to use the skills and competencies passed on to you from our Alma Mater for the good of your profession and society at large. At the end of each graduation ceremony, graduands promise that they will, to the best of their ability, serve humanity—caring for the sick, promoting good health, and alleviating pain and suffering. They recognise that the practice of medicine is a privilege with which comes considerable responsibility and that one's position should never be abused, always abiding in accordance with the Law and Constitution of our country. They also acknowledge that they are now members of the academic body of the University of Malta and pledge themselves to abide by its laws and regulations. It is important that whatever road you might decide to pursue, you will always abide, live and honour this oath professionally throughout your entire career. I urge you to pursue your dreams both locally and internationally. Whatever you do from now on or wherever you decide to go, fly our flag and be proud that you are a graduate of the University of Malta. However, never forget where you started; otherwise, this special occasion today will only be a parody.

'*Life can only be understood backwards, but it must be lived forwards*" ~ Soren Kierkegaard, a Danish philosopher underscores the paradoxical nature of human existence: we can only fully comprehend our lives in retrospect, through reflection and understanding of past experiences, yet we must continue to move forward, navigating the unknown future with courage and purpose. As students, we often encounter problems that seem difficult to overcome. During these times, the pressure and frustration consume us. Each problem seems like a barrier to success. However, as time goes on, we realise that these struggles and problems were the ones that shaped us. We learn lifelong lessons and have a deeper understanding of how to tackle complex issues in life. While our actions and decisions are made in the moment, it's only by looking back that we gain a full appreciation of their meaning. Life must be lived in the present. We make choices, face challenges, and pursue goals in real-time, often without a clear understanding of how these actions will turn out in the future. The only thing we know about the future is that we do not know the future. It is only when we reflect on past experiences that we can see how everything fits together and gains meaning. We understand the connections between our struggles and successes only after time has passed. In essence, Kierkegaard urges individuals to embrace the totality of their existence—to learn from the past, cherish its lessons, and forge ahead with a sense of purpose and determination. He postulates that we must learn from the past, analyse it, and study it, so that one can learn more about oneself and others. When it comes to the future, however, trust yourself.

On behalf of my fellow academic members of staff and our Alma Mater, I would like to congratulate once again all the graduands who today rightly are feeling proud of themselves for having arrived this far. As academics, we are proud of you, too! However, allow me to express my respect to your supervisors because they are the pioneers who have guided you this far despite their daily challenges to ensure that you are fully supported both academically and financially by ensuring investment in research and innovation during your course of studies.

Go out and celebrate, you deserve this together with your loved ones who have supported you this far. Being a mother myself, I know for a fact that parents and close family members suffer with you along your journey to success. Without their support, it would have been more difficult to achieve your goal to get here. Treasure your success, but most importantly, treasure your family, academic supervisors and friends who believed in you from the start of your academic journey. This is not the end of your journey but the start of your future career. May you keep striving hard to improve the quality of life of your nation and beyond. Take what you've learned so far in life and use it to move forward!