Osteoporosis

Clinical Guidelines for Prevention, Diagnosis, and Management
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his highly informative book fills a critical gap in the health care literature. Written by a team of key clinicians and researchers within the fields of medicine, nursing, nutrition, exercise physiology, physical therapy, and health care policy, the book is a comprehensive handbook of evidence-based clinical guidelines for the diagnosis and treatment of osteoporosis. It is specifically designed for frontline health care providers, who are in the best position to detect the presence of osteoporosis early and institute treatment in time to prevent its devastating fractures. The authors also acknowledge the disease and its sequelae as a global problem that will continue to exceed epidemic proportions in the rapidly aging population unless preventive measures are instituted now.

The authors provide compelling statistics profiling the prevalence and impact of osteoporosis on individuals, their families, and society. The book also presents the most current information about the defining pathology of osteoporosis, including a detailed description of the complex process of bone remodeling and a discussion of risk factors that cue primary care providers to rule out osteoporosis. The diagnostic and treatment protocols are particularly thorough, providing exceptional ready-to-hand reference materials for busy clinicians; the appendices point the reader to an extensive listing of additional relevant organizations and online resources.

Given that the presenting symptom of osteoporosis is still most often a fracture, the chapter outlining the surgical repair of common fractures is a valuable resource for frontline health care providers as they prepare their clients with fractures for surgical referral and the ensuing period of postoperative rehabilitation. The vivid descriptions and illustrations of the specific surgical procedures are also instructive to those who provide rehabilitative follow-up care after the surgical procedure has been performed.

The chapter on health care policy is authored collaboratively by a nurse attorney, a nurse practitioner, and a reimbursement specialist. It deals with the bottom line of how to document services within the codes of public payment systems so that preventive and treatment services are available to all who need them.

But the book goes beyond the diagnosis and treatment of osteoporosis. It also includes a discussion of the national and global mandate for community-based educational programs that support lifestyle choices to prevent osteoporosis, starting with helping children achieve their maximum potential bone mass. A particularly innovative community outreach model featuring a mobile unit equipped with a full-body dual
energy X-ray absorptiometry (DXA) machine is described in detail and presented for its use in facilitating early diagnosis for individuals who live in remote regions.

The authors’ practical and in-depth insights challenge the complacency that has too long been the norm and offer new ways of confronting this silent but unwelcome intruder. Our research on osteoporosis is finally yielding the diagnostic and treatment options needed to eliminate osteoporosis in future generations. This book translates emerging findings in a way that will inform and mobilize the health care community toward this increasingly realistic goal. It provides a roadmap of detailed clinical protocols that will arm frontline clinicians from across disciplines with the information they need to significantly reduce the prevalence and impact of osteoporosis at the grassroots level.

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Osteoporosis is a major global health problem that is increasing dramatically as the population ages. The World Health Organization (WHO) estimates that 70 million people worldwide have osteoporosis. Hip fractures are the most severe consequence of osteoporosis and are associated with lengthy hospital admissions, difficulty in performing activities of daily life, nursing home placement, and a high rate of mortality. The annual worldwide incidence of hip fracture is 1.5 million, a number projected to grow to 2.6 million by 2025 and to 4.5 million by 2050.

The economic burden of osteoporotic fractures on society is immense. Each year in the United States, osteoporotic fractures result in more than 500,000 hospitalizations, 800,000 emergency room visits, 2.6 million physician’s office visits, and the placement of nearly 180,000 individuals in nursing homes. It is estimated that each hip fracture represents approximately $40,000 in total medical costs. But the impact of osteoporosis on the personal lives of the patients and their families is even greater. One in five persons who sustain hip fracture end up in a nursing home, and 20% of them die before a year has passed. Two-thirds of the individuals who sustain hip fracture never return to their prefracture level of function, and many lose their ability to walk, even if they were ambulatory before their fracture occurred.

The primary purpose of this book is to address this now preventable health problem by giving busy clinicians the heightened awareness and knowledge they need to reduce osteoporotic fractures in present generations through early diagnosis and treatment and to prevent osteoporosis in future generations. The book is written as a handbook for frontline nurses, physicians, and other clinicians, who on a daily basis see individuals who have osteoporosis or are at risk for low bone density. They are in the best position to identify and teach those at risk early and to institute treatment in time to prevent fractures.

The WHO has declared 2002–2011 as the Decade of the Bone and Joint, uniting nations throughout the world in the commitment of energy and resources to accelerate progress in bone health and prevention of fractures. Keeping in mind this global context, the chapters in this book offer quick reference information about the prevalence and impact of osteoporosis, its signature pathology, and factors that place individuals at risk for developing osteoporosis. Comprehensive but concise clinical protocols are provided, and state-of-the-art diagnostic measures, pharmacological and nonpharmaceutical
therapies, and prevention-based community education strategies are described. One chapter is devoted to surgical repair following vertebral and hip fractures, including the preparation and support of the patient and the family before and during surgery and during the ensuing lengthy rehabilitation process. Attention is also given to important related issues such as dietary requirements, exercise, fall prevention, quality of life, and independence issues. Encouraging information is also provided about emerging technological developments that may enhance our ability to detect and treat osteoporosis even earlier. But access and cost remain formidable issues in the detection of osteoporosis and the prevention of fractures, particularly for underserved and underinsured populations. Our policy and finance specialists address these issues, including Medicaid and insurance reimbursement, in their chapter. They have compiled a comprehensive list of reimbursement codes for diagnostic and treatment procedures to help practitioners apply for and obtain reimbursement for osteoporosis screening and management.

Even more importantly, the editors and contributors hope that this book will have a significant impact on dispelling the insidious but still prevalent mind-set, even among clinicians, that osteoporosis and fractures are an inevitable part of aging. Specifically, we hope the book will raise the consciousness of health-related professionals about the mandate for widespread educational programs for the public, beginning with children of both genders and their parents, to eliminate osteoporosis as a public health problem in future generations.

In summary, although osteoporosis is a devastating public health problem that affects all strata of the global community, there is a sound body of research findings indicating that osteoporotic fractures can be eliminated. And in recent years, pharmaceutical companies have stepped up to the challenge and are developing a sophisticated portfolio of new and improved products that can stop bone loss and build bone density. Data-based risk assessment protocols have proven to be reliable, and bone-scanning technologies are becoming increasingly portable and available to measure bone density with high accuracy, even among outlying populations. Simple but powerful bone healthy life choices are also well documented, and almost everyone in developed countries has now been exposed to the teachings that exercise, adequate calcium, and vitamin D are critical to building and maintaining strong bones. But we must not let up in our efforts. If together we apply what we already know in our practice, we can spare millions of elders in our country and around the world from the shattering experience of vertebral and hip fractures. We ask that you help us achieve this goal by applying the spirit of commitment and information provided in this book with those you see every day in your practice.

Sarah H. Gueldner
Theresa N. Grabo
Eric D. Newman
David R. Cooper
he editors would like to acknowledge and express appreciation to the many individuals and affiliating academic and practice institutions that have contributed to their vision and support to the development and completion of this book. In particular, we would like to thank the team of researchers and clinicians from across disciplines who have provided the high quality and relevant evidence-based information in the chapters. We would also express our deep appreciation to our respective institutional affiliations for their substantial support in terms of both their positive corporate energy and the technical assistance that they have made available to the project. Specifically, they include the Decker School of Nursing and the Bioengineering Department at Binghamton University, in Binghamton, New York; the Frances Payne Bolton School of Nursing at Case Western Reserve University in Cleveland, Ohio; The Knee Center in Wilkes-Barre, Pennsylvania; the Geisinger Health System based in Danville, Pennsylvania, and Valley GYN Specialists in Luzerne, Pennsylvania.

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We offer this quick reference guide to front line clinicians, who are in the best position to detect osteoporosis early and institute treatment measures in time to prevent its devastating fractures. Even more importantly, the editors and authors hope that this book will have a significant impact in dispelling the insidious but still prevalent mind set, even among clinicians, that osteoporosis and fractures are an inevitable part of aging. We hope the book will serve as an impetus to raise the awareness of health related professionals to the mandate for widespread educational programs, beginning with our children and their parents, to eliminate osteoporosis as a public health problem within future generations. Please help us achieve these goals.

Sarah Gueldner, Theresa Grabo, Eric Newman, and David Cooper
The incidence and prevalence of musculoskeletal pain and disability in older people in all parts of the world should be considered as a matter of urgency. (World Health Organization, *The Burden of Musculoskeletal Conditions at the Start of the New Millennium: Report of a Scientific Group*)

**The Problem**

Osteoporosis, leaving behind its devastating wake of fractures, is a major global health concern. And like other chronic diseases that disproportionately affect the elderly, the prevalence of osteoporosis and associated fractures is projected to increase markedly as the population ages. The most devastating consequence of osteoporosis is fracture. In the United States, 1 in 2 two women and 1 in every 5 men over 50 years of age experience an osteoporotic fracture during their lives, and more women die from the aftereffects of osteoporotic fractures than from cancer of the ovaries, cervix, and uterus together. Likewise, the economic burden of osteoporosis on society is sobering.

**The Science**

For years it was assumed that osteoporosis was an inevitable part of aging, and that little could be done. But the state of the art is improving. With recent advances in diagnostic and treatment modalities, it has become clear that it
should no longer be regarded as an untreatable disease. Research in the area of bone disorders has accelerated markedly, providing both the medical community and the public with a more detailed understanding of factors that promote bone health or cause bone disease and fractures. Advances in scientific knowledge have also revealed much about the pathology, prevention, diagnosis, and treatment of osteoporosis and have shown that osteoporosis can someday be prevented in the majority of individuals and identified early and treated effectively in those who do develop it.

**Transferring Knowledge to Practice**

The next critical step in the quest to stop osteoporosis is to transfer the knowledge gained from prevalence data and research findings to the practice of clinicians and the lifestyles of the general public. By focusing on prevention and lifestyle changes as well as early diagnosis and appropriate treatment, Americans and their fellow global citizens can avoid much of the impact of osteoporosis. Health care professionals play a critical role in promoting and supporting these lifestyle choices, and in identifying and treating those at risk early enough to prevent fractures.

**The Clinical Mandate**

Improved methods of routine screening now allow frontline clinicians to diagnose more patients and to diagnose them earlier, significantly slowing the progression of their osteoporosis. But preventing the disease in the first place is paramount to the ultimate management goals. Systematic national and global effort must be directed toward educating the world’s public about the importance of lifestyle habits from childhood through old age. It is imperative that an algorithm be developed and instituted worldwide to support lifestyle changes and early diagnosis of osteoporosis in time to prevent fractures if at all possible.

It has been shown that low bone mass is a function of failing to achieve adequate peak bone mass during childhood and adolescence, and/or the occurrence of a high rate of bone loss during times of vulnerability, as seen during menopause and advancing age. Generic and lifestyle variables (i.e., nutrition, exercise, smoking), chronic disease, and exposure to drugs (such as steroids) known to be associated with rapid bone loss also affect rate of bone loss, superimposed on the influences of age, including menopause.

**Children: An Overlooked At-Risk Group**

Until recently, little attention was given by the primary health care community to the achievement of maximum bone mass in children during their bone development years. Fortunately, that window of opportunity for prevention is gaining considerably more attention. The National Bone Health campaign, Powerful Bones, is a national campaign to promote optimal bone health in girls 9–12 years old to help reduce their risk of
osteoporosis later in life, and healthy bone awareness programs that stress diet and physical activity are increasingly being implemented in elementary schools.

The System Mandate

Individuals and health professionals acting alone cannot make enough of a difference. A coordinated public health approach is the most promising strategy for eliminating osteoporosis in coming generations. However, faced with other pressing health problems such as AIDS, tuberculosis, and malaria, osteoporosis has been relegated to a low priority in most countries. Thus, the persistent challenge is once and for all to erase the lingering misperception that osteoporosis and fractures are inevitable conditions of growing old, and that nothing can be done to prevent them. Toward that purpose, the World Health Organization (WHO), in collaboration with national and international organizations concerned with bone health, has taken the lead in uniting nations around the world in the commitment of effort and resources to improve bone health and prevent fractures. America’s response to that global charge is outlined in the surgeon general’s report of 2004 on bone health and osteoporosis, drafted by more than 100 experts in the field. The report provides state-of-the-science information about bone health and illustrates the large burden that osteoporosis places on our nation and its citizens. The report is intended to alert both the public and the medical community to the importance of bone health, including its impact on overall health and well-being, and the need to take action to prevent, assess, and treat bone disease throughout life. The primary message of the report is that the bone health status of Americans can be improved, and that prevention of bone disease, particularly osteoporosis, begins at birth and is a lifelong challenge.

The Purpose of This Book

Addressing the rapidly increasing prevalence and global impact of osteoporosis, the purpose of this book is to translate research findings related to osteoporosis into concise clinical guidelines for frontline clinicians, who are in a position to make the biggest difference in the future trajectory of the disease. The book is organized around four content areas: (1) prevalence, risk factors, and pathogenesis; (2) clinical management; (3) nonpharmacologic considerations; and (4) prevention strategies. Part I of the book, composed of two chapters, profiles the prevalence, risk factors, and pathogenesis of osteoporosis. Chapter 2 provides an overview of the prevalence of osteoporosis, highlighting its exponentially growing impact on the aging global society. Chapter 3 describes the underlying pathogenesis of osteoporosis, with a detailed discussion of bone remodeling.

Part II of the book, composed of three chapters, provides a detailed discussion of clinical topics germane to the diagnosis and clinical management of individuals with osteoporosis. Chapter 4, written by a physician-hematologist with many years of experience in osteoporosis, profiles diagnostic tests and interpretation, outlining the steps necessary to arrive at a confirmatory differential diagnosis. This chapter also discusses specific characteristics of clinical presentation across gender and
life span and offers data-based protocols for obtaining individual and family history. Chapter 5, contributed by faculty in pharmacology and practice, outlines treatment imperatives, including presently available and future pharmacologic prevention and treatment options. Chapter 6, coauthored collaboratively by two orthopedic surgeons and a physician’s assistant, features the latest information about surgical procedures and perioperative management for the best treatment and rehabilitation outcomes following hip, vertebral, or wrist fracture.

Each of the four chapters in part III describes nonpharmacologic approaches important to the prevention or management of osteoporosis. Chapter 7, written by a professor of nutrition and a public health epidemiologist, provides an overview of nutritional considerations. Chapters 8 and 9, authored by experts in physical therapy, speak to the exercise mandate and the critical aspect of fall prevention. Chapter 10, authored by an occupational therapist, offers protocols that address the personal experience of living with osteoporosis, including maximum functional rehabilitation and psychological adjustment to characteristic body changes.

All the chapters in part IV are directed specifically at steps that need to be taken if we are to eliminate osteoporosis in coming generations. Addressing the irretrievable opportunity to achieve maximum bone mass during childhood and young adult years, chapter 11 is devoted to ways of reaching young girls and boys who are presently building their peak bone mass. The chapter also highlights the potential of school-based health centers as a readily available venue for fostering bone healthy lifestyles in elementary and middle grade children.

Chapters 12 and 13 feature two successful large-scale community osteoporosis education and screening programs designed to enable physician groups and other clinicians to reach even the most remote populations. Chapter 12, addressing the barrier to access, describes an innovative screening and diagnostic program using two DXA-equipped mobile vans that are operated by the rural-based Geisinger Health System and travel throughout their outpost clinic network. Each year this mobile program screens more than 3,000 persons in outlying areas of Pennsylvania, and one-third of those screened are found to have low bone density. Remarkably, the program sustains itself financially.

Chapter 13 describes Creating Health: Osteoporosis, an impressive statewide education and heel-screening program that is disseminated to every county in conjunction with the state-wide network of the Pennsylvania State University Extension Program. The public broadcasting system associated with the extension program enhances the production and delivery of appealing high-quality sound bites to a wide regional audience. Stand Tall Pennsylvania, a successful partnership model for the delivery of a screening and education program to people who live in remote areas of Pennsylvania, is also described.

Chapter 14, written jointly by a nurse lawyer, a nurse practitioner, and a Medicare specialist, provides invaluable information about the role that health policy and insurance reimbursement play in the prevention and management of osteoporosis. The chapter provides detailed how-to information for obtaining reimbursement for procedures related to the diagnosis and management of osteoporosis.

Finally, encouraging information is presented in chapter 15 about innovative non-pharmacological bioengineering theories and technologies under development that hold promise for increasing our ability to detect and treat osteoporosis in time to reduce
Osteoporosis is a severe public health problem that affects all strata of the global community. The good news is that healthy women and men 50–65 years of age still have time to engage in osteoporosis-preventing behaviors to reduce bone loss and eventual height loss. It is imperative that research efforts be continued and expanded to develop additional effective treatment measures with fewer unpleasant side effects, and that both professionals and the general public become better informed about lifestyles that support bone health.

Professional and community education programs are beginning to have an impact in teaching primary care providers and the clients that they serve about the importance of early diagnosis of osteoporosis and the timely institution of treatment. But for best results, more awareness and education efforts need to also be directed toward the young girls and boys who are presently building their peak bone mass, for it is only through their generation and following generations that osteoporosis can be eliminated. Osteoporosis is a lifelong condition that manifests itself in old age, and the best treatment is to engage in bone healthy lifestyles from childhood on. Applying what is already known about prevention, assessment of risk factors, diagnosis, and treatment has led to marked improvements in bone health status. It is the intent of this book to place that state-of-the-science information at the fingertips of primary health care providers and other health-related professionals, to hasten the achievement of that goal.
Prevalence, Risk Factors, and Pathogenesis
The silent epidemic of osteoporosis has been challenged. We are now beginning to appreciate the magnitude of this disorder in our world populations. (R. L. Wolf, “Epidemiology: The Magnitude of Concern”)

Introduction

The prevalence of osteoporosis is typically determined using a classification system suggested in 1994 by an expert panel of the World Health Organization (WHO) (Kanis, 1994; World Health Organization [WHO], 2003). The classification system is based on measurements of the bone mineral density (BMD) of women. A woman’s actual BMD is assessed and then compared to the average peak BMD of a healthy young adult White female reference group. The woman’s deviation from this average (statistical mean) is then calculated in standardized units (i.e., standard deviations or SDs). Women are considered to have a normal BMD if their score falls within 1 SD of the mean. Those whose BMD score falls within 1 to 2 SDs below the mean are classified as having osteopenia, a condition in which the bone loss is not severe enough to warrant classification as osteoporosis. The classification of osteoporosis is given to those whose BMD score is greater than (or equal to) 2.5 SDs below the mean. Women who have a history of fragility fractures and a BMD score greater than or equal to 2.5 SDs below the mean are classified as having severe or established osteoporosis.

It is important to take into account the fact that this classification system, though commonly used, has significant limitations for estimating prevalence across diverse international populations. The applicability of the WHO criteria to groups other than White women is not exact. Current recommendations are to use a White female
reference population for all groups (Radiological Devices FDA Panel Meeting Summary, 1999), although the appropriate cutoff values for osteoporosis and osteopenia in men and other racial and ethnic groups are still under investigation. In addition, the prevalence of osteoporosis may be underestimated when only a single BMD site (e.g., the hip) is used, since an individual with normal BMD at one site may have low BMD at another site (e.g., the spine, wrist). The prevalence of osteoporosis is expected to be higher if a number of skeletal sites are assessed simultaneously (Melton, Atkinson, O’Connor, O’Fallon, & Riggs, 1998). These limitations are important when trying to estimate the prevalence rates of osteoporosis in a given population, especially from a global perspective. Since available estimates are based on these measurements, the authors acknowledge the possibility of variances in the prevalence statistics presented below. Likewise, despite advances in the accurate measurement and interpretation of BMD, it is recognized that the numbers of individuals tested for and diagnosed as having osteoporosis may be underestimated.

Prevalence

Using the WHO definition based on bone density measurement, it is estimated that there are roughly 10 million Americans over the age of 50 with osteoporosis of the hip, and 34 million others with osteopenia of the hip (National Osteoporosis Foundation [NOF], 2002; U.S. Department of Health and Human Services [USDHHS], 2004). Using the WHO criteria for osteopenia and osteoporosis, Looker et al. (1997) reported the prevalence of low femoral bone density in a sample of 14,646 men and women who participated in the Third National Health and Nutritional Examination Survey (NHANES III). The reference population was 382 White men and 409 White women, 20 to 29 years of age. According to the WHO criteria, osteoporosis under age 50 was rare. However, 13% to 18% of women aged 50 or older had osteoporosis, and another 37% to 50% had osteopenia. At the time of this report, those figures translate to 4 to 6 million women with osteoporosis and 13 to 17 million with low bone mass (osteopenia). Further predictions based on the NHANES III study were made for the year 2002 and beyond (NOF, 2002), with a reported expectation that by the year 2002, 7.8 million women and 2.3 million men over age 50 would have osteoporosis, and 21.8 million women and 11.8 million men over age 50 would have osteopenia. The prevalence of osteoporosis in the United States is highest among White women (Hispanic or non-Hispanic). The NHANES III report estimated that 15% of White women met the criteria for osteoporosis (Mirza & Prestwood, 2004). Similar numbers were seen in the Hispanic population; however, the prevalence among African American women was only half as great as was seen in the White and Hispanic populations. The National Osteoporosis Foundation (NOF) estimates that 55% of all Americans aged 50 and older in the year 2002 had either osteoporosis or osteopenia (low bone mass). Based on the 2000 Census, prevalence estimates increased to 52 million women and men for the year 2010, and to 61 million in 2020 (NOF, 2002).

In the United Kingdom, it is estimated that 23% of women aged 50 years or more are osteoporotic, with increases proportional to age (Upton, 2005). The percentages of Swedish women who have osteoporosis range from 7% of women 50–59 years of
The prevalence of osteoporosis is higher for women in Norway than anywhere else in Europe. Estimates of prevalence among African American women are that it is about half that of White women (Mirza & Prestwood, 2004). Asian and White non-Hispanic women have the lowest BMDs throughout life, and African American women have the highest. Mexican American women have bone densities that are intermediate between the two groups. Limited data suggest that Japanese and Native American women attain a peak BMD that is lower than for White non-Hispanic women (National Institutes of Health, 2000).

In 2002, it was estimated that 44 million people in the United States have osteoporosis, with 68% being women and 32% being men (Gueldner, Britton, & Stucke, 2006; NOF, 2002), providing confi rmatory evidence that osteoporosis affects both genders, and that the numbers of individuals with the disease are on the rise. It is estimated that the number of persons with osteoporosis/osteopenia will increase to 52 million by year 2010, and to 61 million by year 2020.

Fractures

Fracture is the most significant consequence of osteoporosis. Although osteoporosis can affect any bone in the body, the most typical sites of fractures related to osteoporosis are the hip, spine, and wrist (NOF, 2006). Of the 1.5 million fractures that occur in the United States each year, 20% occur at the hip, 50% in the spine, and 30% at the wrist and other sites. The annual worldwide incidence of fracture was estimated to be 1.29 million in 1990, and is projected to grow to 2.6 million by 2025 and to 4.5 million by 2050 (WHO, 2003). The highest fracture rates are reported from northern Europe, the northern part of the United States, and among Southeast Asian populations, with the lowest rate from African countries. The risk of hip fracture among Norwegians is four times that of southern Europeans and double that of Americans. It is of note that the differences in incidence of hip fractures between countries are greater than the differences between genders (Chang, Center, Nguyen, & Eisman, 2004; WHO, 2003).

Fracture site is also age related. For individuals in their 50s, wrist fractures are most common. Individuals in their 60s are more likely to sustain fractures of the vertebrae of the spine, and by the time an individual reaches the 70s, the hip becomes the most common site of osteoporotic fracture (Cooper, Campion, & Melton, 1992). The rates of all three types of fracture increase with age, but the increased risk with aging is most pronounced for hip fractures (Kenny, Joseph, Taxel, & Prestwood, 2003; Melton, 1996).

Lifetime Fracture Risks

Considering the lifetime fracture risk for each site, women have about an 18% chance of hip fracture, a 16% chance of vertebral fracture, and a 16% chance of wrist fracture (Melton, Chrischilles, Cooper, Lane, & Riggs, 1992). Again, age-related changes are prominent; by age 50, White women have about a 40% chance of fracturing their hip, spine, or wrist in their remaining lifetime (Cummings & Melton, 2002). This statistic equates to a 4 out
of 10 lifetime risk for significant fracture and a 1 out of 6 lifetime risk for hip fracture for every woman over the age of 50. These risks are equal to the combined risks of developing breast, uterine, and ovarian cancer in the remaining years of life (NOF, 2002).

For men, the estimated lifetime fracture risk is about 13% after age 50 (Cauley, 2002; Cummings & Melton, 2002). The site-specific fracture risks are 6% for the hip, 5% for the spine, and 3% for the wrist. However, even though men age 50 and beyond have a lower lifetime risk for osteoporotic fracture than women, the risk for developing a fracture is almost as great as the risk of developing other conditions common to this age group, such as prostate cancer (Cauley, 2002). The lifetime risk for a White male, based on an age-adjusted incidence rate, is 16.3% (National Cancer Institute, 2006).

The most abundant data available for non-Whites in the United States are related to fractures of the hip. Fang, Freeman, Jeganathan, and Alderman (2004) conducted a study in New York City from 1988 to 2002 in which hospitalization rates for male and female non-Hispanic Whites, Blacks, Hispanics, and Asians over age 50 were tracked. The results showed that the risk of a hip fracture in the three ethno-cultural subgroups was approximately one-third to one-half less than that of Whites. A listing of the top 10 states, by prevalence and estimate increase, is provided in Table 2.1.

### Global Perspectives

The WHO has reported that in 1990, 1.66 million hip fractures occurred around the world (WHO, 2003). Johnell and Kanis (2004) estimated slightly fewer fractures (1.3 million) for the same year, with the most fractures (52.5%) occurring in North America, Japan, Australia, and western Europe, and the least (0.5%) in sub-Saharan Africa. The highest rates of hip fracture have been found to occur in Scandinavia (Woolf & Pfleger, 2002).
2003), with 5-year mortality rates in Sweden following hip fracture reaching 59%, and 72% after fracture of the spine (Johnell et al., 2004).

When considering the geographic distribution of osteoporosis and related fractures, deficiencies in vitamin D cannot be ignored. Vitamin D deficiency may predispose individuals to developing osteoporosis and, subsequently, to suffering osteoporotic fracture. Individuals living north of 42 degrees north latitude (the established northern border for optimal ultraviolet B (UVB) synthesis of vitamin D; Higdon, 2004), such as those included in the Scandinavian region, are at risk for vitamin D deficiencies. Similarly, individuals who cover their bodies or are darker skinned are also at risk for vitamin D deficiencies. A study of Lebanese men and women (both people of dark pigmentation and people who practice veiling) reported a 68.1% vitamin deficiency in this population, with the deficiency being more prevalent in women than men (Ghassan et al., 2004).

Consequences of Osteoporosis

Mortality

Of the three most common sites of osteoporotic fractures, hip fracture poses the most significant insult to the health status of an individual. Increased mortality risk with hip fracture is related to comorbidities such as strokes or chronic lung diseases (Browner, Pressman, Nevitt, & Cummings, 1996), poor health prior to the fracture (Richmond, Aharonoff, Zuckerman, & Koval, 2003), and complications that arise secondary to medical/surgical treatment of the fracture. Excess mortality occurring after a hip fracture, compared with that expected in the population, is estimated to be 12% to 35% higher. A person’s age, race, gender (Center, Nguyen, Schneider, Sambrook, & Eisman, 1999; Ismail et al, 1998; Jacobsen et al., 1992), health, and functional status (Browner et al., 1996; Magaziner et al., 1997) contribute to the survival outcome following hip fractures. The greatest excess mortality typically occurs within the first year (Jacobsen et al., 1992), with one study reporting a death rate of 20% in the first year following hip fracture (Leibson, Tosteson, Gabriel, Ransom, & Melton, 2002). In the same study it was shown that the risk of mortality was four times greater during the first 3 months following the fracture.

Men appear to have a poorer prognosis postfracture than do women (Center et al., 1999). A large prospective study demonstrated that men had poorer survival outcomes than women for hip, vertebra, and other major (e.g., pelvic, rib) and minor (e.g., distal arm and leg) fractures (Center et al., 1999). In general, African Americans fare relatively worse than their White counterparts (Jacobsen et al., 1992) in terms of mortality following hip fracture.

Morbidity

Morbidity, the term used to denote living with the sustained effects of a health disturbance, is of great concern for persons who suffer a fracture. For most, the effects of the event are sustained. Reports from the Established Populations for Epidemiologic Studies of the Elderly (EPESE) confirm that 40%–79% do not regain their prefracture
walking status within a year after hip fracture, and fewer than 50% ever recover their
prefracture ability to perform physical activities of daily living such as eating, dressing,
grooming, or bathing (Greendale & Barrett-Connor, 2001). Further, nearly 1 in 5 per-
sons who sustain a hip fracture will end up in a nursing home, and 20% will die before a
year has passed (Leibson et al., 2002). One study showed that more than half of the men
who suffer a hip fracture are discharged to a nursing home, and that 79% of these men
who survive at 1 year will reside in nursing homes or intermediate care facilities (Poor,
Atkinson, Lewallen, O’Fallon, & Melton, 1995). By comparison, 19% of women who
suffer a hip fracture will require the services of a long-term care facility (Chrischilles, Butler,

In a study of members of a fairly healthy population sustaining a new hip fracture
and then being discharged to their own homes, gait and balance were assessed 2 months
after the fracture and then patients were followed for the next 2 years (Fox et al., 1998).
Both poor balance and poor gait were associated with more admissions to nursing homes
(20% and 17% increases in odds, respectively); however, poor balance, but not gait,
resulted in more hospitalizations and increased mortality rates (a 17% increase with
each unit decrease in balance score) following the fracture. Another study found that
after adjustments for possible confounders, including comorbid conditions, women with
hip fractures were significantly more likely to report difficulty performing 11 out of
15 different tasks, including mobility tasks (e.g., walking two or three blocks), higher-
functioning tasks (e.g., light housework, preparing meals), and basic self-care tasks (e.g.,
bathing, dressing) (Hochberg et al., 1998). Thus, hip fracture presents long-term nega-
tive effects for those who survive the initial threat to health.

In vertebral fractures, morbidity is a profound concern. Osteoporotic fractures of
the spine result in an unnatural, pronounced curvature of the spine (i.e., kyphosis) and
loss of height. These spinal fractures are often called crush fractures—a term that cap-
tures the collapse of the vertebral column onto itself. As the spine loses structural sup-
port, the rib cage moves downward. In some cases, the rib cage eventually comes to rest
on the iliac crests. This downward shift of the body’s structural support pushes internal
organs downward and forward from the thorax toward the abdomen, accentuating an
abdominal protuberance.

These structural changes produce concomitant morbidity: height loss, back pain,
abdominal fullness, and inhibited breathing patterns. Nevitt et al. (1998) reported
the results from a large prospective study of 7,223 older White women who had spine
X-rays at baseline, and at a follow-up examination an average of 3.7 years later as part of
their participation in the Study of Osteoporotic Fractures (SOF). Compared to women
without a spine fracture at baseline, those with at least one new vertebral fracture were
more likely to have increased back pain and back disability. Among women who already
had a fracture at baseline, those with a new incident fracture had a substantial increase
in back pain and functional limitations as well.

Many of these problems subsequently affect other health patterns. For example,
kyphosis is associated with diminished function, especially in mobility tasks like walking
and climbing stairs (Ryan & Fried, 1997). Abdominal fullness is often related to early
satiety (a term referring to early satisfaction and fullness upon eating), which over time
may result in weight loss. Kyphotic changes in posture lead to more shallow respirations,
which have implications should the person affected require surgery or anesthesia. Over
time, severe kyphosis may even lead to chronic lung disease.
The impact of vertebral deformities may be worse for men than for women (Burger et al., 1997; Matthis, Weber, O’Neill, & Raspe, 1998). A large study of 15,570 European men and women showed that the associations between vertebral deformities and negative health outcomes (presence and intensity of back pain, functional capacity, and overall subjective health) were stronger in men than women (Matthis et al., 1998). Similarly, in another prospective study conducted in Rotterdam, the Netherlands, stronger associations were found between severe deformities and detrimental health outcomes in men than in women (Burger et al., 1997).

Even wrist fracture poses morbidity concerns. Colles’ fractures can result in long-term inability to perform household tasks or personal hygiene. Though the impact on function tends to be underestimated, these fractures may have serious lasting effects on everyday life (USDHHS, 2004). It is also important to note that while the consequences of wrist fractures are generally not as serious as those of hip and spinal fractures on presentation, they have great clinical importance as a predictor of future hip fractures. The risk of hip fracture after a wrist fracture is increased 1.4-fold in U.S. women, 1.5-fold in Swedish women, and 1.8-fold in Danish women. Wrist fracture is an even stronger predictor of hip fracture in men; U.S. men who had a wrist fracture were found to be 2.3 times more likely to sustain a hip fracture, and Swedish men with a wrist fracture were 2.8 times more likely to sustain a hip fracture.

From a psychological perspective, postfracture morbidity poses a threat to the overall quality of life. Several factors discussed above contribute to perceived losses in functional, social, and psychological well-being. For example, limited mobility and functional capabilities, pain, and loss of independence are often direct effects of fracture. Deformity, produced as osteoporotic changes invade the spine, is difficult for many to accept. Fear of falling and of subsequent fractures may also pose psychological concerns. In a survey conducted by the NOF, 89% of the women who had sustained an osteoporotic fracture said they were afraid of breaking another bone, 80% feared losing their independence, 80% feared they would not be able to perform their daily activities, and 68% were afraid that they would have to go to a nursing home if they had another fracture. As noted before, approximately half of the individuals who sustain hip fractures never walk independently again, even if they were ambulatory before their fracture (USDHHS, 2004). Such morbidities should not be underattended in the effort to reduce the toll of osteoporosis on the public’s health. Nor is the effect of postfracture morbidity limited to the individual—the effect ripples into the social structures of the adult with osteoporosis. Loss of independence leads to new family roles and responsibilities. Chronic care, offered informally within the family and coordinated with formal caregivers, has its own set of demands and burdens that extend into the network of family and community, and ultimately into society at large. The human and monetary costs of treatment and rehabilitation following fracture are often shared among family members and are partially assumed by public providers. Osteoporosis reaches into the lives and pockets of us all.

Costs

The monetary costs associated with osteoporotic fractures are sobering. In 1995, osteoporosis resulted in 423,000 hospital admissions, 800,000 emergency room visits, 180,000 nursing home admissions, and 2.5 million physician’s office visits. In the United States alone, the annual direct cost for medical care associated with osteoporotic fractures was
estimated to be between $12.2 and $17.9 billion in 2002, with each hip fracture costing $40,000 in medical costs (Töstesen, 1999). Spinal fractures are considerably less problematic in terms of cost, with only 10% requiring hospitalization and fewer than 2% being admitted to a nursing home. However, they account for 66,000 physician’s office visits and at least 45,000 hospital admissions each year (USDHHS, 2004).

Since most of these fractures occur among older adults who are no longer employed, these figures are not heavily weighted by loss of wages. Rather, the costs are associated with direct care services: inpatient care (62%), nursing home care (28%), and outpatient service (10%). Hip fractures account for about 63% of these costs, while fractures at other sites consume the remaining 37% (Ray, Chan, & Thamer, 1997). Given that 75% of all hip, spine, and distal forearm fractures occur in persons 65 years and older, a large portion of the direct costs is borne by society, in the form of social reimbursement programs (Gueldner, Grabo, Britton, Pierce, & Lombardi, 2007). Even the group least susceptible to fracture, non-White men, required $174 million in osteoporosis care in 1995. The significant contribution of nonhip fractures in men and non-White groups to health care expenditures dispels any lingering misconceptions that the impact of osteoporosis is limited to hip fractures among older White women.

### Future Projections

Global graying has become a commonplace reality—the population is living longer, and the proportion of old people within the population is growing. The fastest-growing segment of the population is the oldest-old (i.e., those age 85 years or more). Consider the ramifications of these demographic trends on the incidence of osteoporosis and fracture (both highly associated with increasing age).

Global demographic changes are expected to dramatically increase the prevalence of osteoporosis. By 2050, it is estimated, the number of individuals age 65 and older will be nearly 1.55 billion worldwide. The increase among this population could result in an almost 4-fold increase in the number of hip fractures worldwide (Cooper et al., 1992). That projection equates to a growth from 1.66 million fractures (worldwide) in 1990 to 6.26 million fractures in 2050. The most significant increase in hip fracture rates is expected to occur in third world countries, particularly in Asia (Johnell & Kanis, 2004). Currently, Asia accounts for approximately 30% of global hip fractures. By 2050, it is expected to account for more than 50% of all hip fractures (Ellfors, 1998).

It is imperative that due consideration be given to the collective impact of these fractures on the individual, the family, the community, and society. Osteoporotic fractures represent a phenomenal concern that demands our utmost attention if we are to avert the predicted rapidly increasing trend. Osteoporosis presents a major public health concern. Arresting this preventable disorder must be a major focus of global preventive efforts in this century.

### REFERENCES


