International Development

Prizewinning Dissertation 2025

No.25-TE

Alcohol Consumption as a Forgotten Risk Factor of the Nutrition Transition

Thalia Edwards

Published: Feb 2026

Department of International Development

London School of Economics and Political Science

Houghton Street

London

WC2A 2AE UK

Tel: +44 (020) 7955 7425/6252

Fax: +44 (020) 7955-6844

Email: d.daley@lse.ac.uk

Website: http://www.lse.ac.uk/internationalDevelopment/home.aspx

Abstract:

The Nutrition Transition (NT) framework describes patterns in diet and physical activity levels which underlie the growing global burden of nutrition-related non-communicable diseases (NR-NCDs). The contributions of alcohol consumption to the diet and NR-NCDs across the NT is unexplored. This paper reviews existing literature and performs a descriptive, ecological analysis of country-level trends in alcohol consumption, diet, and physical activity levels, alongside food system development. Findings provide preliminary evidence to suggest an increase in alcohol consumption and associated harms occurring alongside nutritional changes during development – potential amendments to the NT framework to incorporate this are proposed.

List of Abbreviations:

ABV	Alcohol by Volume
AUD	Alcohol Use Disorders
BAC	Blood Alcohol Concentration
BMI	Body Mass Index
CVD	Cardiovascular Disease
DALY	Disability-Adjusted Life Year
DBD	Double Burden of Disease
DBM	Double Burden of Malnutrition
ET	Epidemiologic Transition
EU	European Union
FAO	Food and Agriculture Organization
FST	Food Systems Typology
GBD	Global Burden of Disease
GDP	Gross Domestic Product
HIC	High Income Country
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
Kcal	Kilocalorie
LIC	Low Income Country
LMIC	Lower-Middle Income Country
NCD	Non-Communicable Disease
NR-NCD	Nutrition-Related Non-Communicable Disease
NT	Nutrition Transition
RQ	Research Question
SDG	Sustainable Development Goal
SES	Socioeconomic Status
SSB	Sugar-Sweetened Beverage
TB	Tuberculosis

TNAC	Transnational Alcohol Corporations
TNFBC	Transnational Food and Beverage Corporations
UMIC	Upper-Middle Income Country
UN	United Nations
WHO	World Health Organization

List of Figures:

List of Appendices:

Table of Contents

1. Introduction

The nutrition transition (NT) is a model depicting the major patterns of diet, physical activity, and related nutritional outcomes observed across populations associated with globalisation, urbanisation, and socioeconomic development (Popkin, 1993). Over the last few decades, almost every country has started a shift towards lower physical activity levels and diets high in sugar, fats, sodium, and animal products, and low in fibre and staple foods – collectively termed a 'Western' diet (Popkin & Ng, 2022). The increasing rapidity of these changes in many lower-middle income countries (LMICs) and upper-middle income countries (UMICs) have contributed to the growing global burden of nutrition-related non-communicable diseases (NR-NCDs) such as cancers, cardiometabolic diseases, and obesity (Ronto, Wu & Singh, 2018) – raising serious concerns for global health and development (Baker & Friel, 2014; Tanaka et al., 2014). Thus, the NT has provided an important framework to explain the direct and indirect drivers of nutritional change within the literature, and to anticipate and react to future public health trends in policymaking and the creation of global health targets (Baker & Friel, 2014; Rayner et al., 2017; Popkin & Ng, 2022).

There is great potential for well-designed policies and nutritional programmes to slow, or even curb, increases in NR-NCDs in a population, though approaches narrowly focusing on individual diseases or risk factors have shown limited success in both developing and developed nations (Huse et al., 2022). It is now widely accepted that a range of complementary policy actions spanning sectors, governmental departments, and approaches are needed to successfully tackle the interconnected drivers, processes, and outcomes associated with the NT (Popkin & Ng, 2022; Huse et al., 2022). Similarly, the need for less siloed approaches towards behavioural risk factors including unhealthy diets and alcohol consumption has repeatedly been highlighted, particularly given the overlap in trends, underlying drivers, health outcomes, and strategies used (De Cesare et al., 2013; Butler et al., 2023; Burton et al., 2024).

Like dietary risks and low physical activity, alcohol consumption is additionally a risk factor factor for many NR-NCDs. Alcoholic drinks are nutritive beverages consumed by almost half of adults (15+ years) globally (2019 - WHO, 2024a), that contain the energy-dense and psychoactive nutrient ethanol (Fong et al., 2021). Historically, high rates of alcohol consumption and related harms were primarily characteristic of high-income countries (HICs); but, in recent decades many LMICs and UMICs have observed declines in abstinence rates (Probst, Manthey & Rehm, 2017) and increases in alcohol-attributable mortality and morbidity (Allen et al., 2018) . However, alcohol is not currently acknowledged in any part of the NT (e.g. in Drewnowski & Popkin, 1997; Popkin, 2001; 2006), and no analyses of global alcohol consumption and nutritional outcome patterns in the context of the NT could be found.

The inclusion of alcohol consumption alongside diet and physical inactivity as a risk factor of the NT could have significant benefits. In particular, it would encourage more comprehensive and synergistic (and, therefore, often

more efficient and cost-effective [Burton et al., 2024]) approaches towards the growing burden of NR-NCDs in developing countries and contribute to the achievement of global targets for health and nutrition.

Therefore, this paper aims to establish whether alcohol consumption is a forgotten risk factor of the NT via two research questions:

RQ1. To what extent do patterns of alcohol consumption align with the shifts in diet and physical activity, consequent health outcomes, and underlying processes of the NT model?
RQ2. If the inclusion of alcohol consumption is deemed appropriate, how could the NT framework be amended to reflect this?

Analyses of alcohol consumption trends in the context of development are limited; rarer still are multi-national explorations of how alcohol may contribute to dietary changes and nutritional outcomes. This paper attempts to address the absence (to my knowledge) of analyses considering alcohol consumption over the course of the NT, and provide a preliminary examination of whether, and potentially how, alcoholic beverages could be included into the model. Existing literature on the trends, drivers and health impacts associated with the NT and global alcohol consumption will first be explored. Following this, Marshall and colleagues' (2020) typology of nations by food system development is used to compare trends in consumption and harm attributed to alcoholic beverages with key food groups associated with dietary westernisation over the course of the NT. Evidence from existing literature and ecological data analyses are brought together to suggest that increases in alcohol consumption and attributable harm align with the patterns described in the NT and propose alterations to the existing NT framework.

2. Background

Firstly, to answer RQ1, a comprehensive overview of the nutrition transition (NT) as it currently stands, including trends, drivers, outcomes, perspectives, and positioning within the broader literary context, is necessary. Existing literature exploring the patterns and drivers of global alcohol consumption and harms are then summarised, and parallels are highlighted.

2.1 The NT

2.1a) Framework

The NT was first proposed by Barry Popkin in 1993 to describe the nutritional changes in populations which influence, and are influenced by, the demographic transition from high to low fertility and mortality rates (Dyson, 2010), and the epidemiological transition (ET) away from burdens of infectious disease, undernutrition, and periodic famine, and towards chronic and degenerative diseases (Omran, 1972). The model depicts five patterns of

dietary behaviours, physical activity levels, and associated health outcomes broadly experienced over the course of social, cultural, and economic development (Drewnowski & Popkin, 1997; Popkin & Gordon-Larsen, 2004; Popkin, 2015). However, patterns 1 (collecting food) and 2 (famine) are typically excluded from illustrations (as in Figure 1), since the NT is often used synonymously with the shift from pattern 3 to pattern 4 currently experienced by the overwhelming majority of populations (Popkin, 2002).

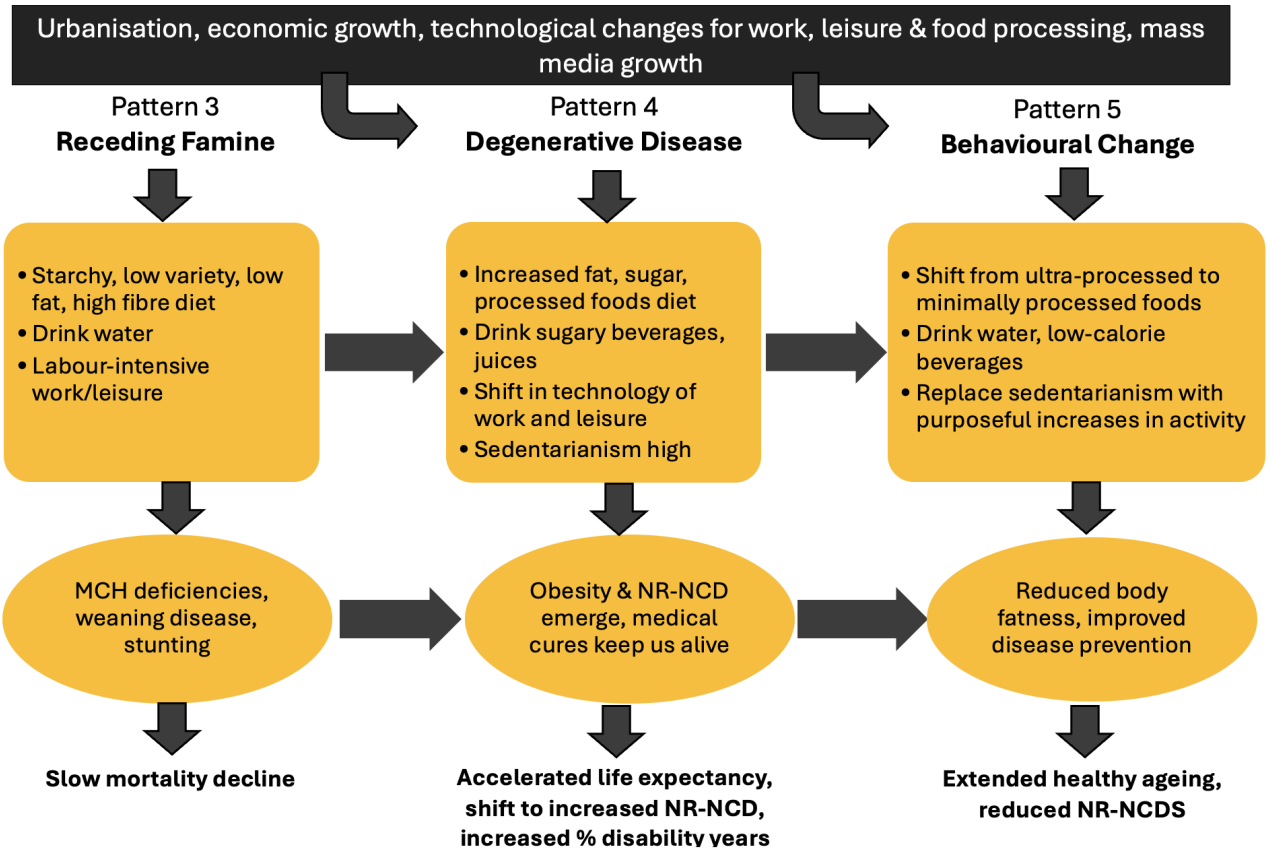


Figure 1. The NT (Popkin & Ng, 2022)

This transition to pattern 4 describes the global convergence towards lower levels of physical activity and a 'Western' diet low in fibre and cereals and high in sugar, saturated fats, sodium, meat, and highly-processed foods, and low in fibre and cereals (Popkin, 2002; Rousham et al., 2020). Nutritional outcomes associated with these risk factors include the growing prevalence of obesity and NR-NCDs linked with the ET's stage of degenerative diseases (Popkin & Gordon-Larsen, 2004; Popkin, 2006; Popkin, 2015). For HICs like the UK, USA, and France, these changes occurred across the 20th century (Popkin, 2002). Shifts to pattern 4 started in the 1980s, 1990s, and 2000s in LMICs and UMICs, but transitions are increasingly occurring much faster than in HICs, and, in some cases, have already resulted in nutritional outcomes, such as obesity, diabetes, and cardiovascular disease (CVD) rates, similar to developed countries (Popkin, 2017). A shift towards more healthful behaviours characterising pattern 5 of the NT and Olshansky's (1986) fourth stage of the ET: the age of delayed degenerative diseases is expected in HICs (Popkin, 2017). However, it is not yet known if any population will fully demonstrate such healthier diets and increased physical activity levels, and the nature and extent of public health policies required (Popkin & Ng, 2022).

2.1b) Drivers of the NT

Diet and physical activity are direct drivers of the NT and major behavioural risk factors for nutritional outcomes shaping global health (Popkin, 2015). Underlying both are multiple processes of change which shape a population's food system, comprising all the inputs, activities, and actors relating to food production, distribution, consumption, and disposal (Baker et al., 2020; Huse et al., 2021). These are termed the indirect drivers of the NT, and include globalisation, global market integration, technological developments, urbanisation, and changes in employment (Popkin, 2006; Popkin & Ng, 2022).

Globalisation & Global Market Integration

Globalisation significantly influences the availability, affordability, and demand for food products (Hawkes, 2006). In recent decades, the costs of producing, distributing, and purchasing foods characteristic of the Western diet have been driven down following greater global market integration, international investments into agriculture, and trade liberalisation (Hawkes, 2006; Baker & Friel, 2014). For example, policies encouraging soybean production and imports in Brazil, India, and China, including reductions in foreign investment restrictions and export tax over the 1980s and 1990s, led to a 60% increase in oil crop production between 1990 and 2003 (Hawkes, 2006). Lower prices and wider distribution meant vegetable oils replaced other oils in cooking and processed food production; consequently, global dietary increases in calories from vegetable oils were faster than any other food group between 1982 and 2002 (ibid.).

The globalisation of national economies also contributes to shifts in the food retail system and encourages an inflow of foreign transnational food and beverage corporations (TNFBCs) (Baker & Friel, 2014). Globally, a small number of TNFBCs have increasingly dominated each aspect of food and agriculture, from manufacturing and processing, to production and, in particular, retail, (Keenan, Monteath, Wójcik, 2023). Supermarkets and convenience stores displace local markets and home food production by using economies of scale to lower fresh food prices and offering a greater diversity of products, including a range of processed foods high in sugars, fats, and sodium, and low in fibre and micronutrients (Baker & Friel, 2014). Higher-income urban dwellers are first targeted, before moving into rural markets (Popkin, Adair & Ng, 2012).

Like shifts to pattern 4, the expansion of transnational supermarket chains like Carrefour and Walmart occurred over the past century in HICs, but more recently and rapidly in developing countries (Popkin, 2017). Across much of Latin America, the proportion of food purchased in supermarkets and grocery stores rose from 15-20% to 60% across the 1990s (ibid.). Over the 2000s and 2010s, similar growth has occurred in Asia in waves (Baker & Friel, 2014).

Technological Changes

Greater access to and use of a range of new technologies over the course of development influences dietary behaviours and physical activity levels (Popkin & Ng, 2022). Rural agricultural workload, for example, is reduced by modern irrigation systems, food storage methods, and transportation links, and small-scale farms are replaced or

bought out by mechanised, commercial farms, often owned or contracted by TNFBCs (Popkin, Corvalan & Grummer-Strawn, 2020). The need to walk or cycle is reduced as trains, cars, and buses become more common; reduced physical activity is also associated with greater phone, television, and computer usage (Popkin & Ng, 2022). Wider access to the internet and social media increases the audience for online marketing and promotions, most prominently for processed foods and sugar-sweetened beverages (SSBs) produced by TNFBCs (ibid.). Since policies restricting the nature and targets of advertisements are typically less stringent or poorly enforced in developing countries, impressionable child audiences may be targeted – this was reportedly extensive in transitioning Asian populations, such as India and Malaysia (Baker & Friel, 2014). Collectively, this drives demand for, and brand loyalty towards, products characteristic of the Western diet in LMICs (Popkin & Ng, 2022).

Urbanisation, Employment, and Income

Urbanisation, driven by demographic shifts, economic growth, and the greater opportunities and services of cities, is associated with shifts towards pattern 4 of the NT (Popkin, Corvalan & Grummer-Strawn, 2020). The aforementioned shifts in retail and technology, including public transport and infrastructural development, occur first in urban settlements, and formal, sedentary jobs become more common (Popkin, Adair & Ng, 2012). Additionally, the improvements in female education and employment rates associated with development are typically more prominent in cities, which, in turn, drives demand for time-saving, affordable, and accessible processed food products (Baker & Friel, 2014). Taken together, nutritional outcomes such as obesity and NR-NCDs increase first in urban centres – although the rapid pace of the NT in many LMICs has been linked to growing rural burdens of NR-NCDs (Rousham et al., 2020), and at an earlier stage of development (Rayner et al., 2017).

2.1c) Nutritional Outcomes of the NT

Broadly, there are two primary shifts in nutritional outcomes and health across the NT: declines in undernutrition and infectious diseases, and increases in overnutrition and NCDs (Popkin, 2007).

Malnutrition

The declining burden of undernutrition, including stunting (low height for age) and wasting (low weight for height), and increase in overnutrition, is a prominent feature of shifts from patterns 3 to 4 (Popkin & Gordon-Larsen, 2004; Reardon et al., 2021). These changes are linked to greater stability and reach of food accessibility, increases in total calorie consumption, particularly from cheap, hyperpalatable highly-processed foods and SSBs, and declines in physical activity (Baker & Friel, 2014; Bhurosy & Jeewon, 2014).

High prevalence of obesity was historically a feature of HICs and higher socioeconomic status (SES) individuals in developing nations; however, LMIC obesity rates have grown rapidly in the 21st century, and are shifting towards lower SES strata (Bhurosy & Jeewon, 2014). The global proportion of adults overweight (Body-Mass Index [BMI] 20-29.9) or obese (BMI >30) has increased from a quarter in 1990 to nearly half in 2022 – over the same period, child overweight grew from 8% to 20% (WHO, 2025). This has been driven by changes in developing countries –

some of which now exceed the 56% average prevalence of adult obesity across HICs, including Egypt (73%), Bolivia (65%) and UMICs like Argentina (68%) and Algeria (58%) (WHO, 2025).

Double Burden of Malnutrition (DBM)

Declines in underweight alongside development have occurred more slowly than increases in overweight; in many cases, this has resulted in a DBM within an individual, household, or population (Popkin, Corvalan & Grummer-Strawn, 2020). Though DBMs are present in every nation (Shrimpton & Rokx, 2012), they predominate in LMICs – particularly where initial undernutrition rates were high, for example, populations in Sub-Saharan Africa (Popkin, Corvalan & Grummer-Strawn, 2020; Reardon et al., 2021). Stunting and micronutrient deficiencies in young children are additionally exacerbated by westernised diets low in nutrient-rich foods, which become more accessible and affordable alongside globalisation (Huse et al., 2022). The health implications of DBMs are under-researched, and addressing one form of malnutrition without worsening the other can pose a challenge to nutritional programmes and policymakers (Ronto, Wu & Singh, 2018). However, double-duty actions that simultaneously target undernutrition, overnutrition, and the broader burden of disease, are growing in popularity (WHO, 2017). These interventions, which typically target the health, welfare, education, and food systems, can double returns while minimising costs and help to establish integrated, coordinated, and sustainable health programmes in LMICs (Hawkes et al., 2020).

NCDs

Popkin notes that the term nutrition-related NCDs (NR-NCDs) is preferred over the narrower diet-related NCDs to encapsulate all behavioural risk factors driving NCD shifts over the NT, including diet, physical activity, and body composition (2002). The most prevalent NR-NCDs are CVDs, diabetes, and cancers.

Cardiometabolic Diseases

The global burden of cardiometabolic diseases is currently growing, particularly in LMICs: between 1990 and 2019, the proportion of deaths from CVDs, including strokes, hypertensive disease, and heart diseases, rose from 26.8% to 33.1%, and from diabetes and chronic kidney disease, from 2.7% to 5.4% (Ronto, Wu & Singh, 2018; GBD, 2024). Shifts towards behaviours typical of pattern 4, such as higher BMIs and lower rates of physical activity, have contributed, given their association with greater cardiometabolic disease risk (Popkin, 2015). Similarly responsible are many features of Western diets, including high sodium intake, which elevates blood pressure and was linked to 1.65 million deaths in 2018 (nearly 10% of all CVD deaths) of which 84% occurred in LMICs (Ronto, Wu, & Singh, 2018). On the other hand, SSB consumption was responsible for 1 in 10 new cases of type-2 diabetes and 1 in 30 of CVD in 2020 (Lara-Castor et al., 2025).

Cancers

Malignant neoplasms were linked to 16.8% of all deaths in 2019 (up from 12.6% in 1990) – 6.8% of which were directly attributed to dietary risks, and 3.5% from high BMI (GBD, 2024). Significant risk factors include low physical activity, which is associated with increased colorectal cancer risk; high BMI with breast, colorectal,

oesophagus, and kidney cancers; and high red and processed meat consumption with colorectal cancers (Key et al., 2004; Popkin, 2007; Ubago-Guisado, 2021).

Double Burden of Disease (DBD)

In a similar pattern to malnutrition, declines in infectious disease rates have occurred more slowly than rises in NCDs in many developing countries (Li et al., 2022). For example, Nigeria, Sierra Leone, and Burkina Faso face growing morbidity and mortality from diabetes, ischemic heart disease, and dementia, whilst malaria still causes over 100 deaths per 100,000 population (2019 - Li et al., 2022). Similarly, coexisting HIV/AIDS and NCD burdens are prevalent in Sub-Saharan African populations (Moyo-Chilufya et al., 2023), and coexisting tuberculosis (TB) and NCDs across South-East Asia and Western Pacific nations (Kapur & Harries, 2013). Many challenges are associated with the management of DBDs, including resource and infrastructural constraints, socioeconomic challenges, slowed rate of development, and unique health issues arising where infectious diseases and NCDs coexist in an individual (Bordirsky et al., 2020; Li et al., 2022).

In sum, the rapid convergence of nutritional behaviours towards pattern 4 of the NT is reflected in the growing and converging challenges posed by nutritional outcomes including overnutrition, NR-NCDs, and double burdens of disease and malnutrition. The NT model has proven an important model in understanding current health and nutritional challenges and has aided progress towards multiple Sustainable Development Goals (SDGs), including SDG 2 (zero hunger) and SDG 3 (good health) (UN, 2015). Additionally, it enables forward-planning in policymaking to anticipate the challenges of future patterns, and demonstrates the broadness and multisectorality of processes underlying health and nutritional changes, thereby encouraging more comprehensive public health policies (Rayner et al., 2017). Though the general reception of the NT model is positive, a few criticisms are commonly expressed. These include its failure to capture the complexity of dietary changes and variation between and within populations (Lang & Rayner, 2005; Hawkes, 2006), and the difficulty in quantitatively measuring the NT, particularly in LMICs, where data may be less consistently available, and standard dietary household surveys may not identify specific food products or groups (Walls et al., 2017).

2.2 Alcoholic Beverages, Nutrition, and Health

This paper proposes that the exclusion of alcoholic beverages, which contribute to diets and are risk factors of NR-NCDs, is an additional shortfall of the NT. The following section summarises the contributions of alcoholic beverages to the diets and nutritional outcomes of drinkers, global trends of alcohol consumption increases alongside economic development, and how these are indirectly driven by similar processes to the NT.

2.2a) Alcoholic Beverages: Overview & Trends

Alcoholic drinks (those containing ethanol) are nutritive beverages which have been consumed across the world for thousands of years, and are major behavioural risk factors for the global burden of NCDs (WHO, 2024a). At 7

kilocalories (kcal) per gram, ethanol is the second most energy-dense nutrient after fat, but lacks other micronutrients or macronutrients; alcoholic beverages are thus often considered a source of 'empty' calories (Key et al., 2004; McClain et al., 2021). However, total nutritional content varies by beverage depending on the percentage of alcohol by volume (ABV) and the addition of other nutrients, for example, sugars and sweeteners in cocktails and alcopops (Swinburn et al., 2004; Pettigrew et al., 2025).

Despite falling under many dictionary definitions of foods as a nutrient-containing substance used for growth and vital processes (e.g. Oxford English Dictionary, 2008; Collins Dictionary, 2025; Cambridge Dictionary, 2025), alcohol is generally considered separately to diet in nutrition and public health (WHO, 2023). Instead, it is frequently perceived as a drug, not a food, since ethanol is a psychoactive, toxic food additive with addictive potential (Lustig, 2020), and grouped with behavioural risk factors like tobacco consumption and substance abuse (Pettigrew et al., 2025). For example, EU policy exempts beverages over 1.2% ABV from nutrient labelling: therefore, nutritional contents and ingredients are not necessary for alcoholic beverages yet are still required on non-alcoholic beers, wines, liquors (WHO, 2023), and drinks containing other food additives with the potential for addiction, such as caffeine (Lustig, 2020). The inclusion of alcoholic beverages is, additionally, inconsistent across the literature in studies on nutrition (Pettigrew et al., 2025). As a result, the dietary contributions of alcoholic beverages go unacknowledged, or are entirely excluded, from models like the NT.

Historically, high levels of alcohol consumption and attributable harm were characteristic of HICs (Maiyaki & Garbati, 2014). However, increasing rates of both have been linked to socioeconomic development in LMICs, and consumption behaviours appear to have started to converge somewhat over the past few decades (Holmes & Anderson, 2017). Pure alcohol consumption increased globally by roughly 70% between 1990 and 2017 (Manthey et al., 2019). Disaggregated by income level, the volume consumed by HICs remained stable, and therefore declined as a proportion of total consumption from 40% to 26% (ibid.). The majority of increases in volume were driven instead by LMICs and UMICs, which, collectively, represented 70% of pure alcohol consumption in 2017, compared to 50% in 1990: by 2030, this is projected to increase further and to comprise around four-fifths of global alcohol consumption (ibid.).

Furthermore, Probst, Manthey and Rehm's 2017 ecological study on lifetime abstinence found a strong negative relationship between GDP Purchasing Power Parity and abstinence in countries without majority-Muslim populations. The greatest declines in abstinence between 1990 and 2017 were observed in South-East Asia and the Western Pacific, and projections from 2017 to 2030 suggest that the WHO Africa region will follow a similar trend (Manthey et al., 2019).

However, there is heterogeneity in trends. Within populations, alcohol consumption and attributable harm are consistently greater in males, although gender disparities appear to reduce over the course of development, and are less prominent in HICs (Hill & Friel, 2020). Internationally, countries with large Muslim populations have higher abstinence rates and, in some cases, restrict or ban alcohol by law, since drinking is prohibited in Islamic teachings

(WHO, 2024a). Across Muslim-majority countries, lifetime abstinence is positively correlated with the proportion of the Muslim population (Probst, Manthey & Rehm, 2017).

2.2b) Drivers of Alcohol Consumption Patterns

The processes underlying alcohol consumption trends mirror the indirect drivers of the NT (see 2.1b for more detail). While regional and global analyses are currently limited, findings from case studies of developing countries suggest that increases in dietary westernisation, physical inactivity, and alcohol consumption often cluster within sub-populations (Pallangyo et al., 2020; Brenes et al., 2021; Burton et al., 2024; Viana et al., 2024). This reinforces the potential of synergistic and comprehensive policies to address these processes and curb the growing global burden of harmful nutritional outcomes.

Globalisation and Global Market Integration

As nations globalise, transnational alcohol corporations (TNACs) with large shares of global markets (Anderson, Meloni & Swinnen, 2018) penetrate national and local markets, similar to TNFBCs (Maiyaki & Garbati, 2014). As abstinence rates decline (Probst, Manthey & Rehm, 2017), traditional, locally-produced alcoholic drinks are replaced by increasingly accessible and widely-marketed industrially-produced beverages, particularly beer and spirits, suggesting some global convergence in drinking choices across development (Parry, 2000).

Technological Development

Perhaps the most significant technological change underlying alcohol consumption is increasing access to telephones, computers, televisions, the internet, and social media. Advertisement campaigns and new products produced by TNACs are often tailored towards younger and female audiences (Esser & Jernigan, 2018; Walls et al., 2020), simultaneously positioning drinking as a form of female empowerment whilst maintaining the larger, male market (Hill & Friel, 2020). This contributes to gendered shifts in drinking cultures and contributes to declines in overall abstinence rates across development (ibid.).

Urbanisation, Employment, and Income

Urbanisation, increasing income, and growth in formal employment have all been linked to increased alcohol consumption in developing countries, alongside declines in physical activity and westernising diets (Vorster, Kruger & Margetts, 2011; Walls et al., 2020; Alfaro et al., 2025). Additionally, as mentioned above, TNACs take advantage of cultural shifts in gender roles, underpinned by greater female workforce participation and therefore economic independence, and grow brand loyalty through online advertisement campaigns (Hill & Friel, 2020).

2.2c) Health and Nutritional Outcomes of Alcohol Consumption

While low levels of alcohol consumption, as part of a balanced diet and healthy lifestyle, are debated to reduce the risk of some diseases, the WHO and Lancet jointly declared that any benefits to human health are outweighed by alcohol-attributable harms at any level of consumption (2023). Ethanol's toxicity, intoxication, and/or dependence

causes short- and long-term harm in the form of disease, injury, and social problems to individuals and those around them; even in light (<10g pure alcohol/day) and light-to-moderate (<20g pure alcohol/day) drinkers (Rovira & Rehm, 2020; Anderson et al., 2023; Babor et al., 2023).

Injuries and Alcohol Poisoning

In 2019, approximately 724,000 deaths occurred from alcohol-attributable injuries – comprising 16% of all deaths from injury and 28% of total alcohol-attributable mortality (2019 - WHO, 2024a). The psychoactive nature of alcohol can impair attention span, reaction time, and judgment, worsen coordination, and affect mood and emotions: thereby increasing injury risk to drinkers and those around them (Babor et al., 2023). Risk of injury grows alongside blood-alcohol concentration (BAC) from low levels of consumption (MacKillop et al., 2023). Laws banning driving with BAC over a certain level, or even after any drinking, are commonplace; nevertheless, it remains a major cause of alcohol-related injury, alongside falls, drownings, homicides, and suicides (ibid.). At high BACs, additional morbidity and mortality may also arise from alcohol poisoning (WHO, 2024a).

Alcohol Use Disorders (AUDs) and Foetal Alcohol Syndrome

7% of the global population over 15 years of age live with AUDs, around half of which (3.7% of global population) with alcohol dependence (WHO, 2024a). These conditions are characterised by an impaired ability to control drinking behaviours, regardless of social and occupational consequences, and an increased risk of most other forms of alcohol-attributable harms (Anderson, 2021; MacKillop et al., 2023). Despite relatively high prevalence, AUDs are underacknowledged and underdiagnosed; across all countries with available data, no more than 14% of individuals suffering from AUDs received treatment in 2019 (WHO, 2024). In pregnant women, particularly those with AUDs, moderate-to-heavy drinking is also associated with permanent birth defects like foetal alcohol syndrome, which has long-term physical and neurodevelopmental consequences (Rehm et al., 2017; Babor et al., 2023; WHO, 2024).

Infectious Diseases

Alcohol consumption adversely impacts innate and acquired immune system functioning thereby increasing vulnerability to many infectious diseases – particularly in populations with significant infectious disease burdens, including parts of Sub-Saharan Africa and South-East Asia (Bygbjerg, 2012; Rehm et al., 2017). For light-to-moderate drinkers, immune system impacts are limited, but worsen following heavy drinking episodes; chronic heavy drinkers and individuals with AUDs are most significantly impacted, and at much greater risk of diseases like active TB infections and pneumonia (Rehm et al., 2017).

Behaviours associated with alcohol consumption additionally can raise the infection risk or severity of certain infectious diseases (Rehm et al., 2017; Morojele et al., 2021). The crowded social environments where alcohol is often consumed facilitate the spread of airborne diseases like TB (Morojele et al., 2021). Additionally, the influence of alcohol on decision-making and risk-taking increases the likelihood of risky sexual behaviours such as condomless sex and, therefore, the spread of sexually-transmitted diseases like HIV/AIDS (ibid.). Chronic alcohol

use is linked with worsened adherence to treatments such as Pre-Exposure Prophylaxis and antiretroviral therapy, which are necessary to prevent HIV infection and eliminate transmission (Rehm et al., 2009). Similar effects are observed in the adherence and completion of antibiotic courses to treat TB, contributing to the spread of disease and development of drug-resistant strains (ibid.).

NCDs

Like diet and physical activity rates, alcohol consumption is a risk factor for many NR-NCDs, diseases comprising the greatest proportion of global alcohol-attributable harm (WHO, 2024a).

Digestive Diseases

Alcohol use is responsible for around half of the global burden of liver cirrhosis, which comprises a fifth of all alcohol-attributable mortality (Lopez et al., 2014; Rehm et al., 2018; Simpson et al., 2019). Heightened risk of liver disease is linked to light levels of drinking and accelerates alongside increased consumption (Rehm et al., 2018). This is multiplied if multiple risk factors coexist: for example, risk of liver disease from alcohol consumption and obesity together is 1.6 times greater than the combined risk from each (Burton et al., 2024). The severity of alcohol-related liver injury and disease is also greater alongside undernutrition (Barve et al., 2017), and obesity (McClain et al., 2021).

Cancers

Ethanol is carcinogenic; therefore, any level of alcohol consumption increases individual cancer risk. For cancers of the lip, oral cavity, pharynx, oesophagus, colon, rectum, and larynx, this relationship is almost linear; for liver and female breast cancers, risk increases accelerate at higher levels of consumption (Rehm et al., 2018; Rossi et al., 2018; Ferreira-Borges et al., 2025). For certain nutrition-related cancers, there are multiple behavioural risk factors, including alcohol consumption (see 2.1c), and therefore, co-occurrence may exacerbate risk. This includes colorectal cancer, for which low physical activity, low consumption of fibre, and high consumption of meat, fat, and alcohol are all risk factors; and breast cancer in postmenopausal women, for which obesity and alcohol are risk factors (Key et al., 2004).

Cardiometabolic Diseases

The relationship between alcohol consumption and CVDs is complex. Chronic and heavy drinking increases risk of hypertension, heart disease, stroke, and cardiomyopathy (Rehm et al., 2017; Shield et al., 2020). However, some evidence suggests that light alcohol consumption, particularly wine, may slightly decrease CVD risk: though results have varied by study and geographically, and debate surrounds the extent to which positive associations are overestimated considering confounding factors, such as lifestyle and age of study participants (Rehm et al., 2017; WHO & Lancet, 2023). Nevertheless, the relationship between alcohol consumption and CVD incidence is generally agreed to follow a J-shaped curve (ibid.).

Alcohol consumption and diabetes have a similarly complex relationship. Low levels of alcohol consumption have been shown to have a protective effect in women, but not men, for whom diabetes risk increases with heavy episodic drinking (Rehm et al., 2017). Taken together, the estimated alcohol-attributable burden of diabetes mortality in 2019 was actually slightly negative at -0.3% (WHO, 2024a).

Alcohol and Nutrition

Establishing the impact of any individual nutritive food or drink, including alcohol consumption, on under- and overnutrition is incredibly challenging, given the numerous confounding factors and practical and ethical issues with long-term dietary study design (Butler et al., 2023). As such, evidence on the relationship between low to moderate alcohol consumption and BMI is inconsistent, but heavy drinking is frequently linked to greater weight and waist circumference, particularly following beer and spirits, but not wine, consumption (Kwok et al., 2019; Pallangyo et al., 2020; Brenes et al., 2021). Many factors underlie this, including the high energy density of ethanol, the sociodemographic characteristics and cultural influences of beverage choices and drinking habits (Kwok et al., 2019), and a slight increase in desire for and reward of savoury foods whilst drinking (Schrieks et al., 2015). Furthermore, intestinal nutrient permeability is influenced in heavy drinkers, which can contribute to deficiencies in micronutrients, including vitamins and zinc (Barve et al., 2017; Butts et al., 2023). The position of alcohol consumption as a potential risk factor contributing to DBMs requires further research to establish the extent, nature, and policy implications for developing countries.

Taken together to address RQ1, evidence from the literature suggests significant alignment between global trends in alcohol consumption, diets, and physical inactivity; the relationship between economic development, greater consumption, less prevalent abstinence, and global behavioural convergences draws parallels with dietary westernisation in pattern 4 of the NT. The similarity in processes indirectly driving trends and the consequent burden of NR-NCDs, which, under Popkin's (2002) definition, should include alcohol-attributable NCDs, support further exploration of global alcohol consumption trends in the context of the NT in the following sections.

3. Methodology

Economic indicators, particularly income group classifications, have been used in the majority of previous studies to analyse trends in diet across the NT (e.g. Popkin, 2001; 2006; Baker et al., 2020; Popkin, Corvalan & Grummer-Strawn, 2020; da Costa et al., 2022; Huse et al., 2022), and changes in alcohol consumption (e.g. Probst, Manthey & Rehm, 2017; Manthey et al., 2019). As discussed in 2.1a and 2.2a, economic development is associated with transitions, but does not fully capture the effects of indirect drivers, including globalisation and urbanisation (Popkin, 2001; 2006). In 2021, Marshall and colleagues published a food system typology developed for the Food Systems Dashboard. Though relatively new, it has been adapted by the Food and Agriculture Organization (FAO) for the 2024 edition of *The State of Food in Agriculture*, and has found various uses throughout the literature –

most notably, in Ambikapathi and colleagues' (2022) analysis of global food transitions. This paper utilises the food system typology to represent progression across the NT and descriptively analyse national trends in secondary datasets on behaviours and harms related to alcohol consumption and dietary westernisation.

3.1 Data

Datasets were selected based on suitability and public availability, and results were retrieved for the 155 nations comprising the food systems typology. A full list of sources, countries included by figure, and data retrieval dates are available in Appendix 1.

National estimates of daily per capita calories available for human consumption produced by FAO online database FAOSTAT between 1961 and 2022 were selected to explore changes in consumption (2025a). Exports, losses, usage for seeds, livestock, and non-human food uses, are subtracted from total calorie supply, based on national production and imports, then divided by total population to obtain per capita values. Kcal/capita/day available from animal products, sugar and sweeteners, and vegetable oils were retrieved to represent dietary westernisation, alongside alcoholic beverage kcal/capita/day. Total calorie supply (kcal/capita/day) was also obtained to represent overall dietary calorie availability, which is expected to increase over patterns 3 and 4 of the NT, and were used to calculate the proportion of the diet that each food group comprised.

Data from WHO Global Health Observatory on alcohol consumption behaviours between 2000 and 2022 were also obtained. The prevalence of abstinence was determined from the percentage of adults (15+ years) reporting no alcohol consumption at any point over the last 12 months. Abstinence rates were used to estimate three-year averages in per capita litres of pure alcohol consumed in drinkers. Additionally, the percentage of drinkers reporting heavy episodic drinking (at least 60g of pure alcohol on at least one occasion) over the past 30 days in a population was obtained (greater detail on calculation methods can be found in Poznyak et al., 2014 and WHO, 2024a).

Estimates of deaths attributable to each risk factor (diet, high alcohol use, and low physical activity) were retrieved from the Institute for Health Metrics and Evaluation's Global Burden of Disease (GBD) study (2024). Overall risk-attributable death rates (per 100,000 population) were selected alongside rates grouped by causes: communicable, maternal, neonatal and nutritional diseases; non-communicable diseases; and total cancers. Results from 2019 are presented in box plots to highlight averages and variation: though annual results are available until 2021, data from 2019 were selected to avoid the potential influences of the COVID-19 pandemic, which are not yet fully understood (WHO, 2024a).

3.2 Food Systems Typology

Marshall and colleagues' (2021) food systems typology (FST) considers the complex systems and structures underlying national food environments to place 155 countries (representing around 97% of the global population) into 5 categories:

FST 1. Rural & Traditional,
FST 2. Informal & Expanding,
FST 3. Emerging & Diversifying,
FST 4. Modernising & Formalising,
FST 5. Industrialised & Consolidated.

Classifications are determined based on 4 indicators of food system development: agricultural value added per worker, share of dietary energy from staples, supermarkets per capita, and mean urban proportion of the population (Marshall et al., 2021). Each indicator was selected following a scoping review and the creation of a conceptual food systems framework (Appendix 2; ibid.): see Marshall et al. (2021) for greater detail on assumptions, methods, and justifications of indicators. A table of countries included by FST can be found in Appendix 1.

Individually, each variable is highly correlated with income (GDP per capita), but collectively, they more closely represent the indirect drivers of the NT, and more adequately capture complex relationships between food environments, income, and development that are lost in income group categorisations (Marshall et al., 2021; Ambikapathi et al., 2022). This is evident in the spread of income groups across the typology: while the majority of HICs are grouped into FST 5 (30/44 countries), and LICs in FST 1 (18/21 countries), LMICs are present in all classifications but FST 5, and UMICs in all except FST 1. In light of the increasingly rapid transitions occurring at an earlier stage of economic development, this typology provides a useful basis on which to consider the lack of global alcohol trend analyses in the context of NT within the literature, and potentially aid in hypotheses generation for future research in this area (Marshall et al., 2021; Ambikapathi et al., 2022).

3.3 Analysis

Analyses, data tidying, calculations, and graphical outputs were produced using statistical computing software *R* version 4.3.1 (2023), with the *ggplot2* package (Wickham et al., 2019). Descriptive trends of 155 countries with available results for each metric and FST categorisation were graphed. Smoothed average lines (coloured in red) were produced by *ggplot2* using the method *loess*.

The percentage of dietary calorie intake by food group was calculated for every country for each year in the period by dividing food group kcal/capita/day by total kcal/capita/day and multiplying by 100.

3.4 Limitations

Limitations in the following areas were identified in the analyses, food systems typology, and selected secondary data sources as follows:

Analysis: a descriptive approach was selected to observe trends in alcohol consumption in relation to dietary changes and identify areas for more detailed analyses – statistical significance is not calculated and cannot be inferred in any instances. Other standard limitations of ecological studies are present, including regional and individual trends within countries being overshadowed, the equal weighting of countries despite substantial variation in area and population size, and the challenges with accounting for confounding factors.

Food systems typology: a single, five-stage classification of food systems cannot capture heterogeneity within and between nations, the complex and dynamic reality of food systems, and may wrongly encourage the perception of food system transitions as linear progressions across FSTs. Rankings can only represent recent results for each of the four indicators, and cannot capture any aspect of food system diversity not reflected in the indicators selected. The development of retrospective classifications would be preferable to reflected changes in FST over longer periods of change.

Data: FAOSTAT calorie supply balances are widely and consistently available for most nations and food groups over half a century. Methodological changes were introduced from 2010 onwards (see FAO, 2025b for full details), which reduce the reliability of long-term comparisons. Additionally, quality varies where data collection infrastructure is poor and/or limited, food production and trade is largely informal, or significant alcohol consumption is unrecorded. Calorie estimates cannot account for food wastage and therefore likely overestimate calories consumed to varying extents, and cannot capture the variations in products consumed within each food group, or trends in the supply of different macro- and micronutrients.

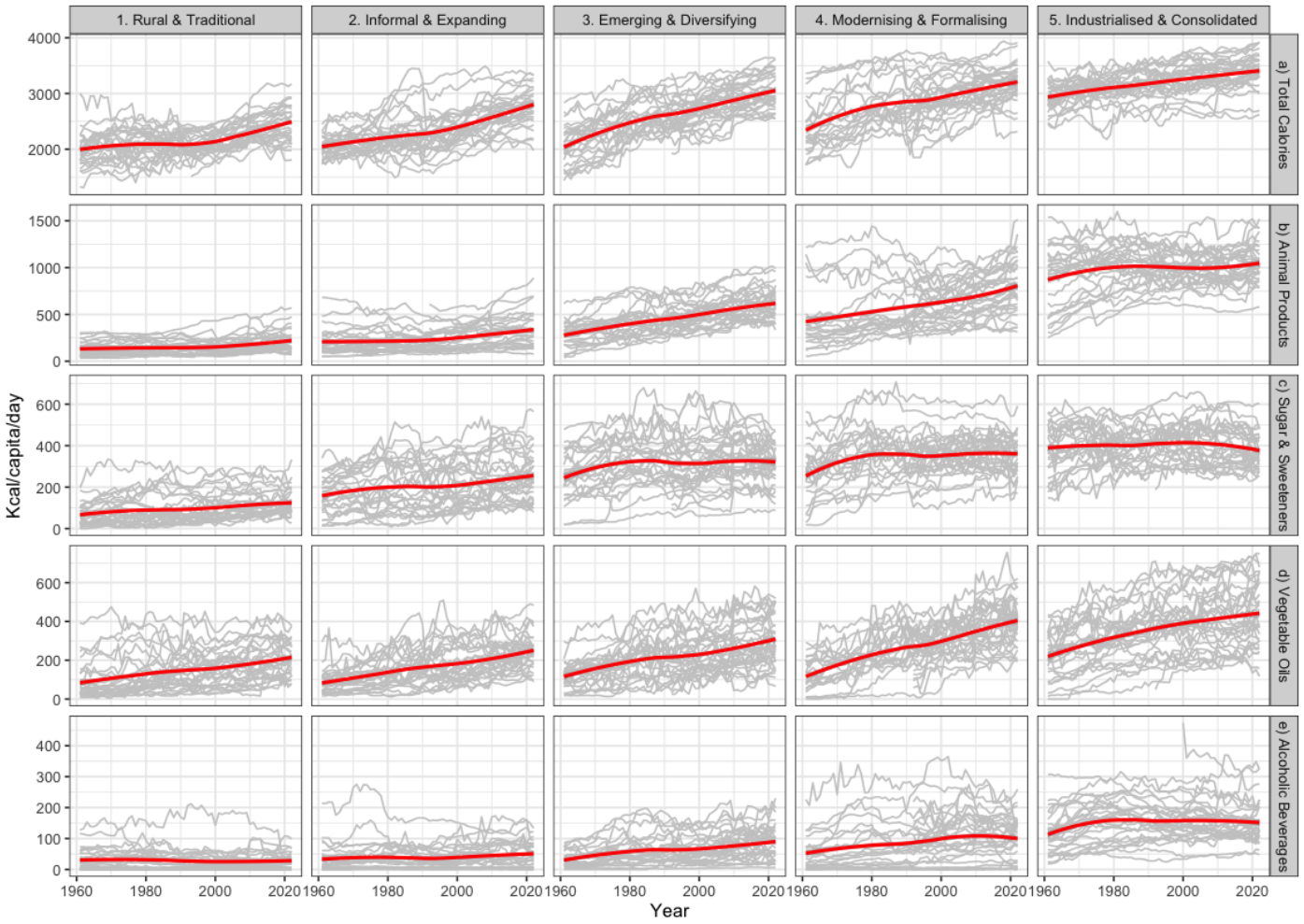
Alcohol consumption behavioural trends were limited to only two decades, reflecting the period for which data are available from the Global Health Observatory. Individual drinking behaviours such as abstinence and heavy episodic drinking cannot accurately be inferred from sales data. Therefore, estimates rely heavily on national and international surveys which are susceptible to individual reporting biases, and the typical underestimation associated with self-reported consumption levels (WHO, 2024a). The WHO additionally noted that the quality and sources of surveys may vary (ibid.).

The use of death rates over Disability-Adjusted Life Years (DALYs) limits the ability to infer trends in the burdens of disability. This decision was made on the basis of the following methodological concerns in DALY calculation. DALYs are the sum of years of life lost from the disease (years between premature mortality age and the optimal

lifespan) and years lived with disability (weighted to value worsened health state and years at a younger age more greatly). The determination of weightings and optimum lifespan is unclear, and the quantitative ranking of health states is ethically debated – calling the validity, reliability, and sensitivity of DALYs into question (see Beresniak et al., 2025 for more details).

4. Results

Figure 2. Daily kilocalorie supply (kcal/capita/day) a) in total, and from b) animal products, c) sugar & sweeteners, d) vegetable oils, and e) alcoholic beverages in 155 countries aggregated by FST, 1961-2022.



Average total kilocalorie supply (kcal/capita/day) rose between 1961 and 2022 (Fig. 2a) in all FSTs. The 1961 average supply of 2,000 kcal/capita/day in countries with Rural & Traditional food systems (FST 1), remained steady until the year 2000, from which point increases occurred to reach a 2,500 kcal/capita/day average by 2022. Similarly, average total kcal supply was 2,000 kcal/capita/day for Informal & Expanding (FST 2), and Emerging & Diversifying food systems (FST 3) in 1961 – following increases across the entire period, 2022 averages were just under and over 3,000 kcal/capita/day, respectively. The rate of increase varied, however: accelerating across the period in FST 2 nations, but decelerating in FST 3. Modernising & Formalising food systems (FST 4) also experienced a consistent, but reducing, growth in calorie supply from an average of roughly 2,500 to 3,250 kcal/capita/day. In Industrialised & Consolidated food systems (FST 5), calorie supply increased from 3,000 to 3,500 kcal/capita/day averages between 1961 and 2022, at a slow, but consistent, pace.

Daily kcal supply from animal products remained low in FST 1 and FST 2, but increased slowly over the latter half of the period to kcal/capita/day averages of around 250 and 300 respectively (Fig. 2b). This equates to 7-8% of FST 1 and 10-12% of FST 2 total calorie supply between 1961 and 2022 (Appendix 3a). In FST 3 and FST 4 nations, on

the other hand, consistent growth resulted in over 500 kcal/capita/day increases, with respective average calorie supplies of roughly 600 and 750 – more than double 2022 averages for FST 1 and 2 (Fig. 2b). Despite overall total calorie increases, the proportion attributed to animal products increased from 14% to 25% in FST 3 countries, and 17% to 25% in FST4 (Appendix 3a). Following a slight increase over the first few decades, FST 5 average calorie supply from animal products remained around 1,000 kcal/capita/day between 1980 and 2022 (Fig. 2b) – comprising, on average, just under a third of total calorie supply (Appendix 3a).

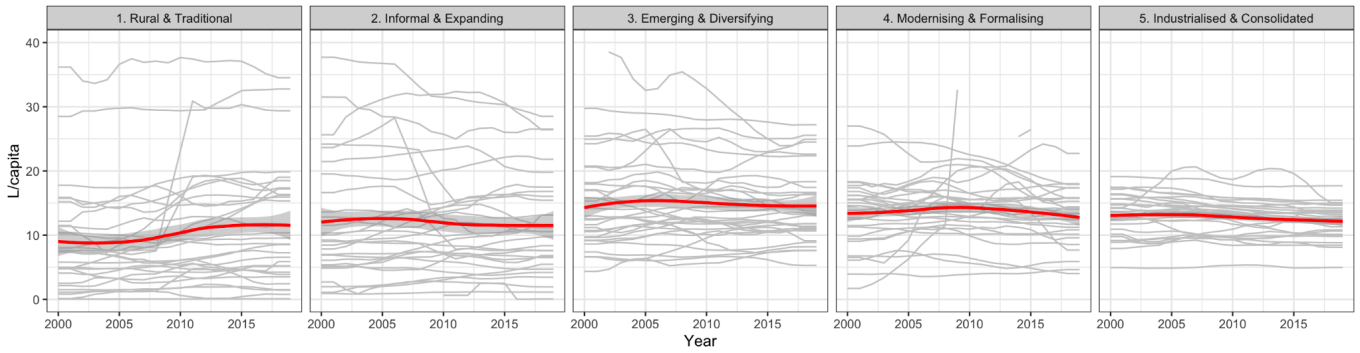
Increases in calorie supply from sugar and sweeteners, compared to animal products, were more significant between 1961 and 2022 in the lower FSTs, with averages rising from roughly 80 to 120 kcal/capita/day for FST 1 nations, and 160 to 260 kcal/capita/day in FST 2 (Fig. 2c). Rates of increase roughly matched total calorie growth, so, proportionally, sugar and sweeteners comprised around 5% and 9% of total calorie supply respectively (Appendix 3b). Increases were confined to the first few decades for FST 3 and 4, with averages remaining around 300 and 350 kcal/capita/day between 1980 and 2022 (Fig. 2c), and, proportionally, declining from 13% to 10% of FST 3 and 13% to 11% of FST4 average total calorie supply (Appendix 3b). For FST 5, daily calories from sugar and sweeteners remained at an average of 400/day across the period (Fig. 2c), equating to a 13% to 11% decline in the proportion of total calories (Appendix 3b).

All FSTs demonstrated significant growth rates in calorie supply from vegetable oils, with 1961 kcal/capita/day doubling in all cases (Fig 2d), and proportion of total calorie supply rising from averages of 5% to 10% in FST 1-3, 5% to around 13% in FST 4, and from roughly 7% to 13% in FST 5 nations (Appendix 3c). In sum, growth in daily calorie supplies from animal products, sugar and sweeteners, and vegetable oils occurred between 1961 and 2022 for all FST excluding 5 – consistent with the global convergence towards westernised diets described by pattern 4 of the NT.

Patterns in daily calorie supply from alcoholic beverages (Fig. 2e) were most similar to animal products between 1961 and 2022 across food system development (Fig. 2b), though dietary contribution was lesser. Alcoholic beverage daily calorie supply remained low for most FST 1 and FST 2 countries (although the latter did demonstrate a slight increase over the period), equating to roughly 2% of total daily kcal supply, in both cases (Appendix 3d). Growth was consistent in both FST 3 and 4, approximately doubling averages from 40 to 90 and 50 to 100 kcal/capita/day between 1961 to 2022 (Fig. 2e), resulting in increased percentages of total calorie supply (Appendix 3d). Patterns in alcoholic beverage calorie supply were also similar to animal products in FST 5 nations, with initial increases between 1961 and 1980 to an average of 160 kcal/capita/day, which remained consistent for the rest of the period, consolidated countries, alcoholic beverage calorie supply similarly followed similar patterns to animal products, increasing between 1961 and 1980 to an average of 160kcal/capita/day and remaining around this level for the rest of the period, contributing around 5% of total dietary calories. It is worth noting that averages in food systems earlier in development were brought down by countries with very low calorie supplies from alcoholic beverages. Nevertheless, overall patterns in dietary calorie supply demonstrate increases over food system

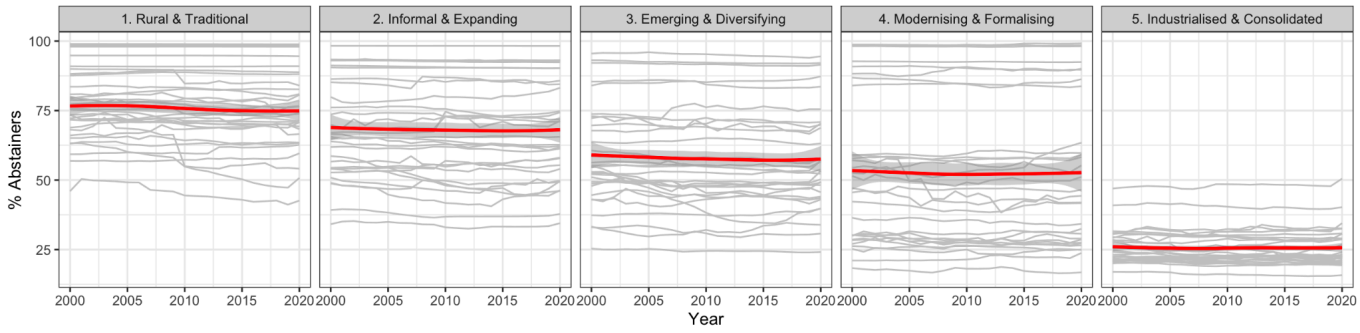
development and across the period, particularly FST 3 and 4, showing some alignment with patterns associated with dietary westernisation – in particular, changes in animal products.

Figure 3. Annual pure alcohol consumption in drinkers (litres/capita, 3-year average) in 152 countries aggregated by FST, 2000-2020.



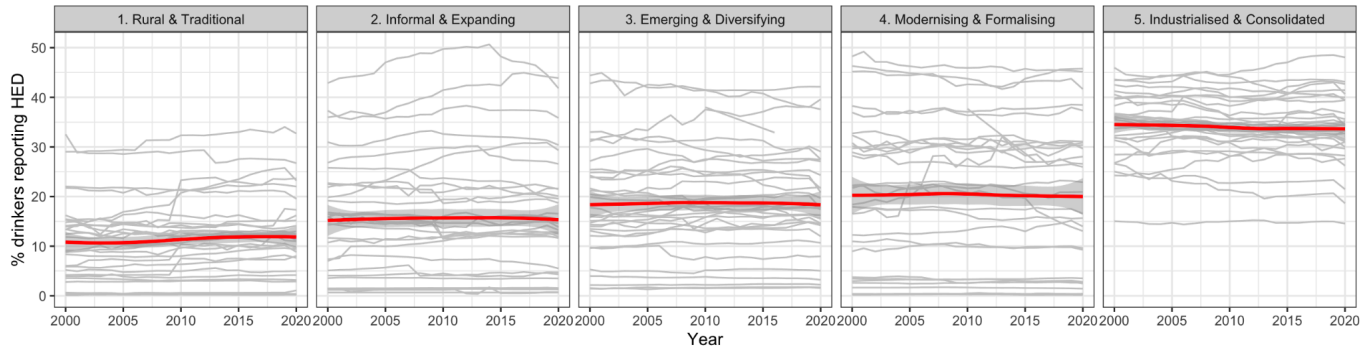
Average volume of pure alcohol (L/capita/year) consumed by drinkers were relatively similar across FSTs between 2000 and 2022, with period averages showing slight incremental increases across FST 1-3, and declines between FST 3-5 (Figure 3). FST 1 was the only group for which yearly average increased over the period, rising from 9 to 11 L/capita/year. For FST2 and 3, system averages were relatively consistent between 2000 and 2020, at roughly 12 and 15 L/capita/year. The latter two FSTs showed slight declines over the period, from averages of 14 to 13 and 13 to 12.5 L/capita/year in FST 4 and 5, respectively, and international variation within both groups appeared more convergent than previous FSTs.

Figure 4. Proportion of adult population (15+ years) abstaining from alcohol over the past 12 months in 154 countries aggregated by FST, 2000-2020.



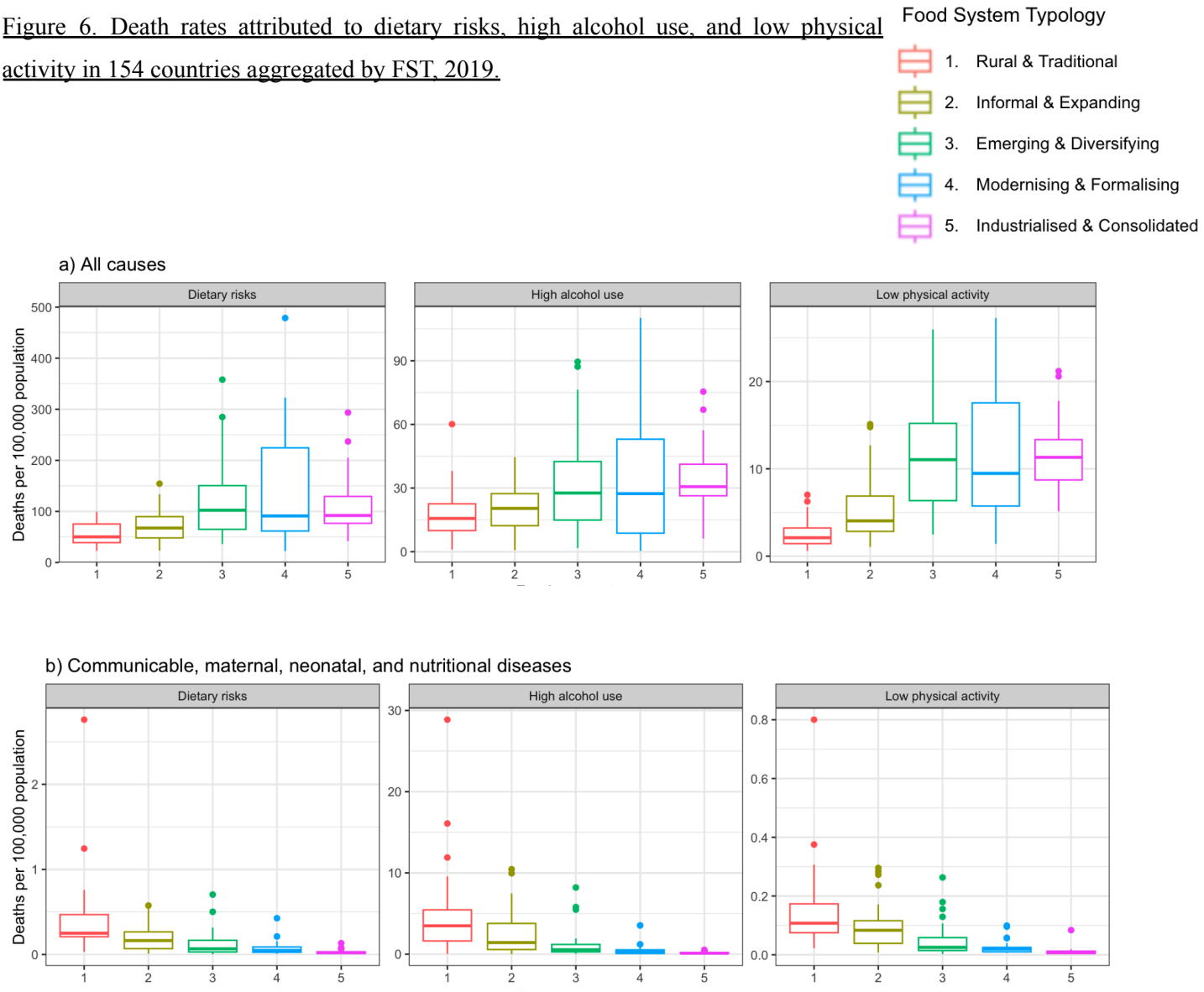
Between 2000 and 2020, each FST demonstrated slow declines in the percentage of adults abstaining (Figure 4). More significant is the incremental decline in abstinence over food system development: FST 1 average abstinence proportions were around 75% compared to roughly 70% in FST 2; 60% in FST 3; 55% in FST 4, and 25% in FST 5. Similar to Fig. 3, variation is much greater in early FSTs, partially attributed to countries with extremely limited alcohol consumption, whilst FST 5 nations show substantial convergence.

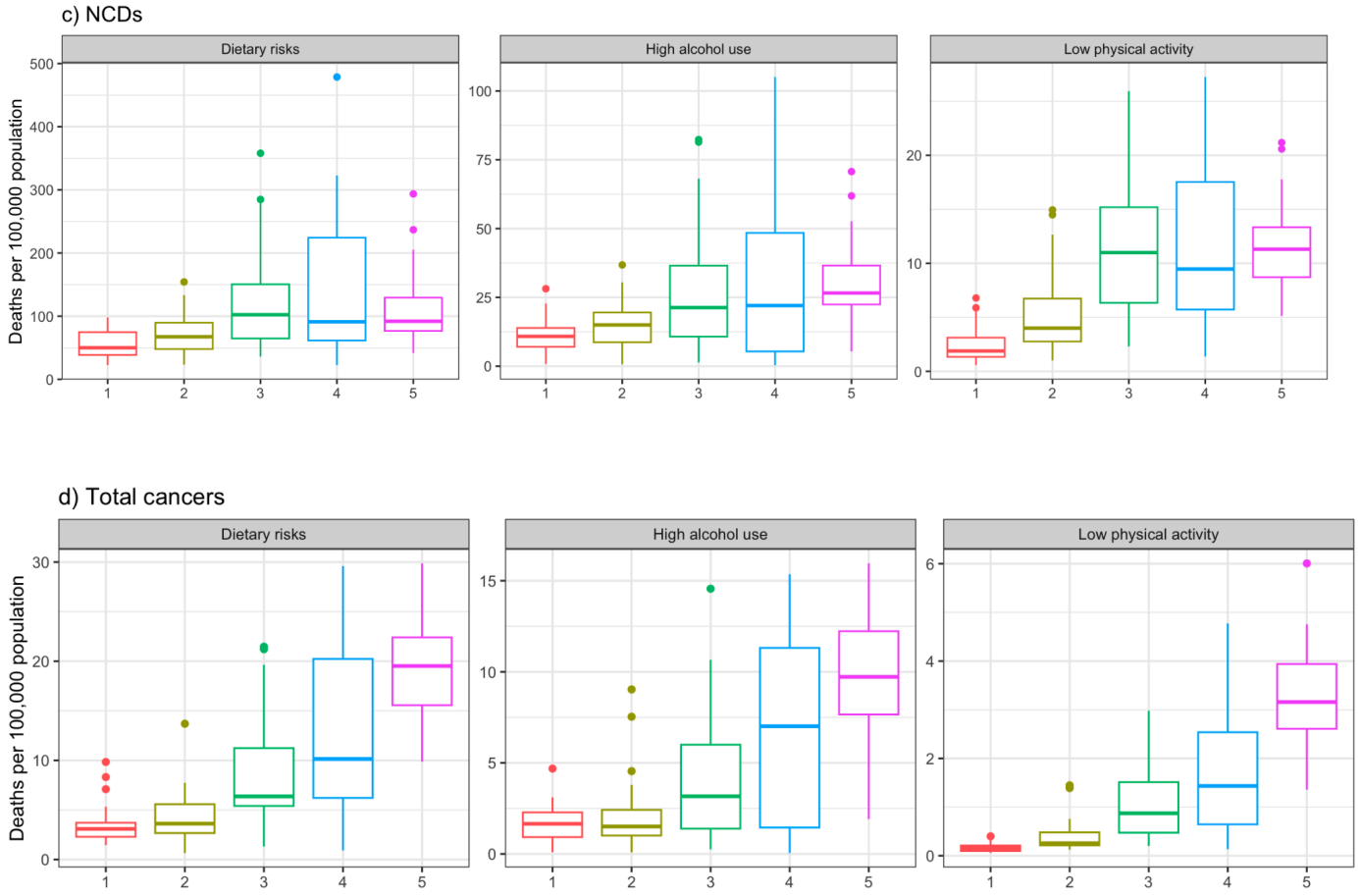
Figure 5. Percentage of drinkers reporting heavy episodic drinking (HED: >60g pure alcohol on at least one occasion over the past 30 days) in 154 countries aggregated by FST, 2000-2020.



As in Figures 3 and 4, changes in the average proportion of drinkers reporting HED over two decades are relatively limited for each FST (Figure 5). Across food systems, however, averages increase from roughly 11% in FST 1; 15% in FST 2; 18% in FST 3; 20% in FST 4 and 34% in FST 5.

Figure 6. Death rates attributed to dietary risks, high alcohol use, and low physical activity in 154 countries aggregated by FST, 2019.





Death rates from alcohol consumption and the two risk factors directly driving the NT (diet and physical activity levels) are illustrated for each FST in 2019 (Figure 6). Though all-cause death rates attributed to dietary risks are greater than alcohol use, and low physical activity-attributable death rates are the lowest of the three, similar trends are depicted over food system development, which align with the shifting health outcomes across patterns 2-5 of the NT (Fig. 1).

Broadly, all-cause death rates rose across food system development for all three risk factors, with the most significant increases between FST 1, FST 2, and FST 3 (Fig. 6a). Median death rates from dietary risks and high alcohol use in FST 3 (102 and 28 deaths per 100,000, respectively) were almost double FST 1 (50 and 16 deaths per 100,000), and over five times greater, for low physical activity (11 vs 2 deaths per 100,000). Median death rates were more similar over FSTs 3-5: between 92 and 102 deaths per 100,000 population from dietary risks; 27 and 31 from high alcohol use; and 11 to 12 from low physical activity. The interquartile range, however, increased over food system development between FST1 to 2, likely reflecting the heterogeneity in transitions by nation, but smaller in FST 5 nations, suggesting convergence in behaviours later in pattern 4 of the NT.

Communicable, maternal, neonatal, and nutritional diseases death rates attributed to each risk factor (Fig. 6b) are relatively low – particularly for dietary risk and low physical activity. Greater alcohol-attributable mortality rates align with its negative impact on many infectious diseases, particularly in populations where burdens are still great.

Nevertheless, the declines illustrated across food system development for all three risk factors align with the shift away from more significant burdens of infectious, maternal, and nutritional diseases of pattern 3.

The majority of risk factor-attributable death rates are from NR-NCDs – therefore, overall FST trends in NCD death rates (Fig. 6c) follow similar patterns to all-cause (Fig. 6a), as discussed above. Figure 6d demonstrates the proportion of these caused by cancers, which show more substantial increases, particularly across later food systems, compared to total NCD death rates for each food system. Median dietary risk-attributable death rates from cancers over FST 3-5 rose from 6 to 10 to 20 deaths per 100,000 population, alcohol-attributable cancer death rates from 4 to 7 to 10 deaths per 100,000, and cancer deaths from low physical activity, from 0.8 to 1.4 to 3.2 deaths per 100,000 population. Compared to the greater consistency in NCD death rates, with the greatest increases occurring in earlier FSTs, this suggests that death rates from other NCDs may start to flatten, or even decline, later in food system development.

5. Discussion

Descriptive analyses of ecological data support findings from the literature review. Taken together to answer RQ1, global patterns in the consumption and health outcomes attributed to alcohol, diet, and physical activity appear to align, providing positive preliminary evidence supporting the incorporation of alcohol into later NT patterns.

Analyses of national calorie supplies broadly demonstrated the increased consumption of food groups linked to Western diets, and greater alcohol consumption over the last half a century and over food system development (Fig. 2e). Heterogeneity exists between trends for each food group, as expected given the range of processes and policies influencing global food markets and agriculture between 1961 and 2022. This is most evident for vegetable oil, for which national and international policy and market shifts since the 1980s (explored in section 2.1b) drove significant increases for all FSTs.

Patterns in calorie supply over the period and between FSTs are most similar between alcoholic beverages and animal products. In FST 1, both were consistently low; in FST 2, slight increases occurred in the latter half of the period; the greatest growth over the period occurred in FSTs 3 and 4; and, in both food groups, the greatest average calorie supply and proportion of total calories were found in FST5, increases were slower, and only described in the 1960s and 70s. Changes in sugar and sweetener calorie supply followed a similar pattern, but appeared to start earlier in food system development. These results align with the global dietary shifts towards pattern 4 of the NT described in the literature (e.g. Popkin & Ng, 2022) and therefore support the use of FSTs to analyse NT trends. Additionally, results indicate that increases in average calorie supply and the proportion of the diet attributed to alcoholic beverages increase alongside dietary westernisation in national populations.

Results from figures 3-5 indicate that population-level increases in alcohol consumption over food system development are largely driven by declining abstinence rates, rather than greater per capita consumption in drinkers. While the average volume of pure alcohol consumed by drinkers increased by 1-2L/capita/year between FST 1-3, this only equates to one or two extra alcoholic beverages per week; considering the high abstinence rates and low daily calorie supply from alcoholic beverages in FST 1 and 2, these changes are relatively minor. Similarly, while annual litres of pure alcohol consumed by drinkers declined by 1-2 L across the latter three FSTs, population increases in calorie supply from beverages increased as declining proportions of the population reported abstinence. Declines in abstinence over food system development are consistent with the literature review, and would be expected given greater access to alcohol in supermarkets, and the shifts in drinking behaviours and gender equity following urbanisation, mass media and advertising, and shifting employment patterns (see 2.2b).

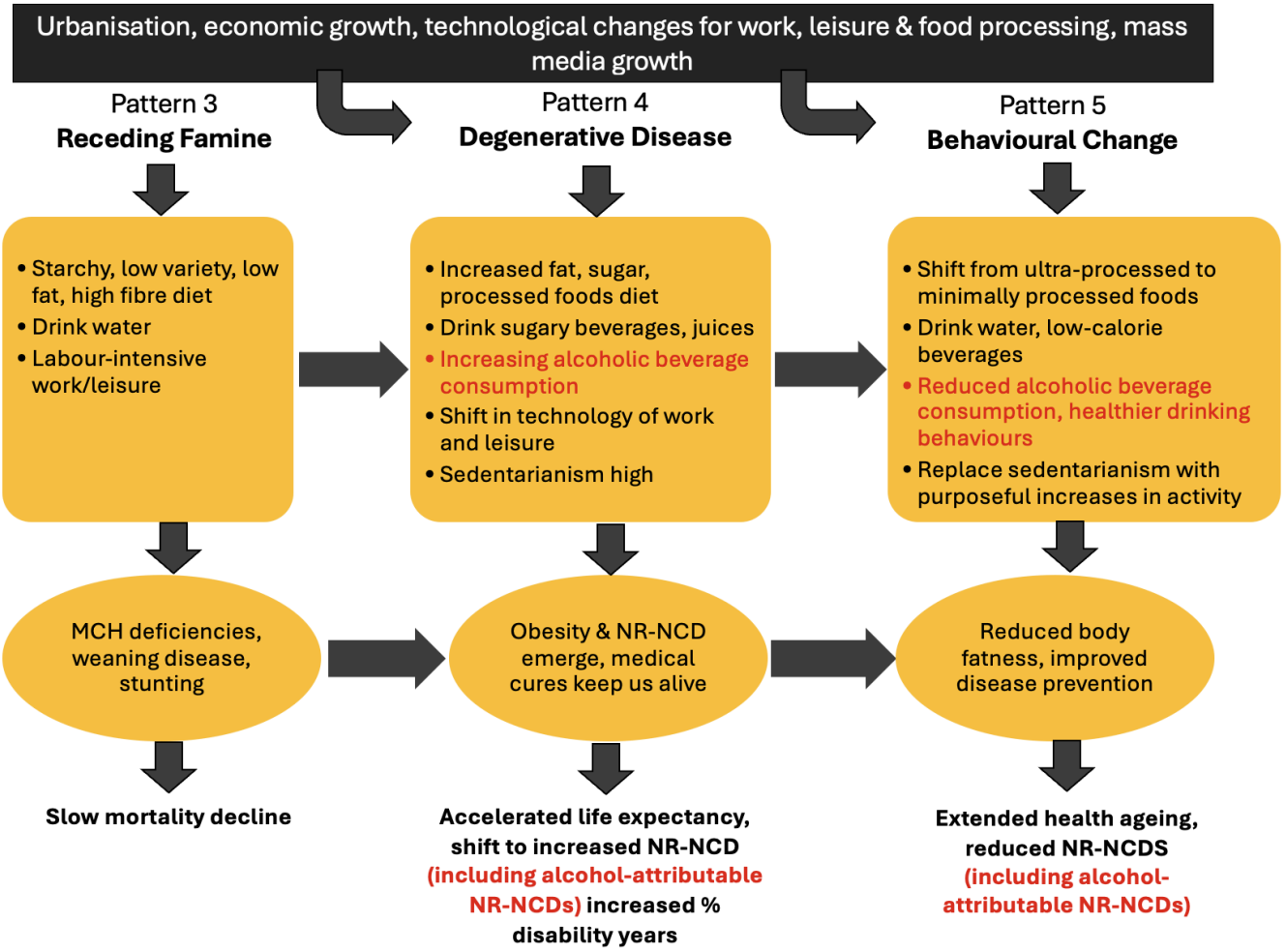
Death rates attributed to high alcohol use and the direct drivers of the NT (dietary risks and low physical activity) in 2019 show similar patterns across food system development (Fig. 6a-d). For each risk factor, median all-cause death rates increased across FST 1-3, which slowed, if not entirely stalled, for FST 4 and 5. Since the primary cause of deaths were NR-NCDs, similar patterns were observed in NCD death rates. The proportion of deaths from communicable diseases was much smaller, but declined between FST 1 and 2, and were close to 0 for the FST 3-5, reflecting the close relationship between the NT and ET.

An additional trend across analyses was evident in the variation between nations within each food system. Nations were the most convergent in consumption patterns, behaviours, and nutritional outcomes in FST 5; in earlier food systems, variation was much greater, and results from countries with very low alcohol consumption rates compared to the rest of the FST appeared to decrease group averages. One takeaway is a likely convergence in alcohol consumption behaviours in later stages of food system development. However, greater research is needed to explore the impacts on overall FST trends of nations with cultures of religious beliefs underlying abstinence rates of 90-100%, and, additionally, whether any unique trends occur in these populations specifically over food systems development.

In sum, country-level trends suggest that, over the course of the NT, alcohol consumption may increase alongside westernising diets, and converge towards patterns found in more developed food systems, consequently raising alcohol-attributable NR-NCDs. It is increasingly recognised that more comprehensive, multisectoral approaches are needed in public health and policymaking in order to more effectively and affordably tackle the growing international burden of NCDs and meet global health targets like SDGs 2 and 3 by 2030. Given the calorie contributions of alcoholic beverages to the diet (Fig. 2) and the impacts of drinking on satiety and nutrient absorption (section 2.2c), the neglection of alcohol in dietary analyses may overlook a potentially important aspect of nutrient intake and digestion, and may have significant consequences for populations with simultaneously growing DBMs and alcohol consumption rates, such as in Sub-Saharan Africa. The same could be said for NR-NCDs, for many of which (e.g. cancers and cardiovascular diseases) diet, physical activity and alcohol consumption all contribute to burdens of harm, and may even amplify risk collectively.

The inclusion of alcoholic beverages into the NT could have wide-reaching benefits, including greater awareness of alcohol as a risk factor for NR-NCDs and contributor to diets; more frequent inclusion of alcohol into analyses of nutritional change; and greater unity in policies anticipating or tackling changing diets, physical activity levels, and alcohol consumption rates, benefiting approaches which address the interconnectedness and synergies in patterns and underlying processes. To answer RQ2, suggested amendments to the NT framework to incorporate alcohol consumption are illustrated in below:

Figure 7. NT framework including alcohol consumption (adapted from Popkin & Ng, 2022 - amendments in red).



6. Future Research

This paper provided an initial exploration of alcohol consumption in the context of the NT. As intended, this has highlighted numerous areas which would benefit from further research.

To establish and evaluate trends further statistical analyses from which significance could be inferred would be beneficial. Additionally, more detailed comparisons between trends in the consumption of alcohol and a variety of

food products and groups, and changes in nutrient intake, would enrich understanding of changes in the diet over the transition, and links between specific food groups and drivers over development. Furthermore, greater analyses into trends of beverage choice and drinking culture, including the context, location, and volume of alcohol consumption, are needed for a greater understanding of the extent of changes and convergence. Availability and analyses of trends prior to 1961 would also benefit understanding of any changes in the position of alcohol within the NT over the past century and beyond, amongst the significant changes in national and global food systems.

Moreover, there is much to be explored within more specific trends of alcohol consumption change, with greater comparison between regions, nations, and within nations. At the global level, this includes trends in male-female differences in alcohol consumption and harm and how this may be influenced by food system development, and the examination of trends in Muslim-majority countries more specifically, including whether alcohol consumption behaviours change in any way within these populations, over the NT.

7. Conclusion

A review of existing literature and descriptive analysis of ecological data provided promising preliminary evidence to support the inclusion of alcohol in the NT. Alcoholic beverages contribute to the overall nutritional intake of drinkers and are major risk factors for NR-NCDs, including cancers, digestive diseases, and CVDs. Declines in abstinence and increases in consumption linked to economic development in the literature were additionally driven by similar processes underlying the NT, including globalisation, urbanisation, and technological changes. Descriptive trends in alcohol consumption, drinking behaviours, and attributable harm over food system development aligned with patterns of dietary westernisation and death rates attributed to low physical activity and dietary risks. Taken together, this creates a considerable argument that alcohol consumption is a risk factor previously forgotten from the NT: potential amendments to the NT framework were suggested.

Overlooking the contributions of alcoholic beverages to the diet and nutrition-related health shifts risks excluding a source of dietary nutrients and contributing to nutrition-related disease risks in the literature, health governance, and progress towards global health targets like the SDGs. Given the significant value of the NT for policymakers in understanding and anticipating health and nutrition trends over the course of development, it is vital that the incorporation of alcohol, a forgotten risk factor in the context of the NT, is considered and explored further.

8. References

Alfaro, T. et al. (2025) 'Variability and social patterning of cancer mortality in 343 Latin American cities: an ecological study', The Lancet Global Health, 13(2), pp. e268–e276. Available at: https://doi.org/10.1016/S2214-109X(24)00446-7.

Allen, L.N. et al. (2018) 'Socioeconomic status and alcohol use in low- and lower-middle income countries: A systematic review', Alcohol, 70, pp. 23–31. Available at: https://doi.org/10.1016/j.alcohol.2017.12.002.

Ambikapathi, R. et al. (2022) 'Global food systems transitions have enabled affordable diets but had less favourable outcomes for nutrition, environmental health, inclusion and equity', Nature Food, 3(9), pp. 764–779. Available at: https://doi.org/10.1038/s43016-022-00588-7.

Anderson, B.O. et al. (2023) 'Health and cancer risks associated with low levels of alcohol consumption', The Lancet Public Health, 8(1), pp. e6–e7. Available at: https://doi.org/10.1016/S2468-2667(22)00317-6.

Anderson, K., Meloni, G. and Swinnen, J. (2018) 'Global Alcohol Markets: Evolving Consumption Patterns, Regulations, and Industrial Organizations', Annual Review of Resource Economics, 10(Volume 10, 2018), pp. 105–132. Available at: https://doi.org/10.1146/annurev-resource-100517-023331.

Anderson, P. (2021) 'The Impact of Alcoholic Beverages on Human Health', Nutrients, 13(12), p. 4417. Available at: https://doi.org/10.3390/nu13124417.

Babor, T.F. et al. (2023) 'Alcohol: no ordinary commodity', in Babor, T. F. et al., Alcohol: No Ordinary Commodity. 3rd edn. Oxford University PressOxford, pp. 13–25. Available at: https://doi.org/10.1093/oso/9780192844484.003.0002.

Baker, P. et al. (2020) 'Ultra‐processed foods and the nutrition transition: Global, regional and national trends, food systems transformations and political economy drivers', Obesity Reviews, 21(12), p. e13126. Available at: https://doi.org/10.1111/obr.13126.

Baker, P. and Friel, S. (2014) 'Processed foods and the nutrition transition: evidence from Asia', Obesity Reviews: An Official Journal of the International Association for the Study of Obesity, 15(7), pp. 564–577. Available at: https://doi.org/10.1111/obr.12174.

Beresniak, A. et al. (2025) 'Reevaluating health metrics: Unraveling the limitations of disability-adjusted life years as an indicator in disease burden assessment', World Journal of Methodology, 15(1). Available at: https://doi.org/10.5662/wjm.v15.i1.95796.

Bhurosy, T. and Jeewon, R. (2014) 'Overweight and Obesity Epidemic in Developing Countries: A Problem with Diet, Physical Activity, or Socioeconomic Status?', The Scientific World Journal, 2014, p. 964236. Available at: https://doi.org/10.1155/2014/964236.

Bodirsky, B.L. et al. (2020) 'The ongoing nutrition transition thwarts long-term targets for food security, public health and environmental protection', Scientific Reports, 10(1), p. 19778. Available at: https://doi.org/10.1038/s41598-020-75213-3.

Brenes, J.C. et al. (2021) 'Alcohol Contribution to Total Energy Intake and Its Association with Nutritional Status and Diet Quality in Eight Latina American Countries', International Journal of Environmental Research and Public Health, 18(24), p. 13130. Available at: https://doi.org/10.3390/ijerph182413130.

Burton, R. et al. (2024) 'The relationship between the price and demand of alcohol, tobacco, unhealthy food, sugar-sweetened beverages, and gambling: an umbrella review of systematic reviews', BMC Public Health, 24(1), p. 1286. Available at: https://doi.org/10.1186/s12889-024-18599-3.

Butler, J.L. et al. (2023) 'Associations of 5-year changes in alcoholic beverage intake with 5-year changes in waist circumference and BMI in the Coronary Artery Risk Development in Young Adults (CARDIA) study', PloS One, 18(3), p. e0281722. Available at: https://doi.org/10.1371/journal.pone.0281722.

Butts, M. et al. (2023) 'The Influence of Alcohol Consumption on Intestinal Nutrient Absorption: A Comprehensive Review', Nutrients, 15(7), p. 1571. Available at: https://doi.org/10.3390/nu15071571.

Bygbjerg, I.C. (2012) 'Double burden of noncommunicable and infectious diseases in developing countries', Science (New York, N.Y.), 337(6101), pp. 1499–1501. Available at: https://doi.org/10.1126/science.1223466.

Cambridge English Dictionary (2025) food. Available at: https://dictionary.cambridge.org/dictionary/english/food (Accessed: 12 June 2025).

Collins English Dictionary (2025) FOOD definition and meaning |. Available at: https://www.collinsdictionary.com/dictionary/english/food (Accessed: 12 June 2025).

da Costa, G.G. et al. (2022) 'Worldwide dietary patterns and their association with socioeconomic data: an ecological exploratory study', Globalization and Health, 18, p. Article number: 31.

Di Cesare, M. et al. (2013) 'Inequalities in non-communicable diseases and effective responses', Lancet (London, England), 381(9866), pp. 585–597. Available at: https://doi.org/10.1016/S0140-6736(12)61851-0.

Drewnowski, A. and Popkin, B.M. (1997) 'The Nutrition Transition: New Trends in the Global Diet', Nutrition Reviews, 55(2), pp. 31–43. Available at: https://doi.org/10.1111/j.1753-4887.1997.tb01593.x.

Dyson, T. (2010) Population and development: the demographic transition. London: Zed.

Esser, M.B. and Jernigan, D.H. (2018) 'Policy Approaches for Regulating Alcohol Marketing in a Global Context: A Public Health Perspective', Annual Review of Public Health, 39(Volume 39, 2018), pp. 385–401. Available at: https://doi.org/10.1146/annurev-publhealth-040617-014711.

Ferreira-Borges, C. et al. (2025) 'Labels warning about alcohol-attributable cancer risks should be mandated urgently', The Lancet Public Health, 10(5), pp. e358–e359. Available at: https://doi.org/10.1016/S2468-2667(25)00040-4.

Fong, M. et al. (2021) '"Joining the Dots": Individual, Sociocultural and Environmental Links between Alcohol Consumption, Dietary Intake and Body Weight—A Narrative Review', Nutrients, 13(9), p. 2927. Available at: https://doi.org/10.3390/nu13092927.

Food and Agriculture Organization (2024) The State of Food and Agriculture 2024. FAO. Available at: https://doi.org/10.4060/cd2616en.

Food and Agriculture Organization (2025a) FAOSTAT. Available at: https://www.fao.org/faostat/en/#home (Accessed: 24 July 2025).

Food and Agriculture Organization (2025b) Food balance sheets and supply utilization accounts resource handbook 2025. Available at: https://openknowledge.fao.org/items/30e641b1-6d57-4998-8e8a-395727aa4307 (Accessed: 24 July 2025).

Hawkes, C. (2006) 'Uneven dietary development: linking the policies and processes of globalization with the nutrition transition, obesity and diet-related chronic diseases', Globalization and Health, 2(1), p. 4. Available at: https://doi.org/10.1186/1744-8603-2-4.

Hawkes, C. et al. (2020) 'Double-duty actions: seizing programme and policy opportunities to address malnutrition in all its forms', The Lancet, 395(10218), pp. 142–155. Available at: https://doi.org/10.1016/S0140-6736(19)32506-1.

Hill, S.E. and Friel, S. (2020) '"As Long as It Comes off as a Cigarette Ad, Not a Civil Rights Message": Gender, Inequality and the Commercial Determinants of Health', International Journal of Environmental Research and Public Health, 17(21), p. 7902. Available at: https://doi.org/10.3390/ijerph17217902.

Holmes, A.J. and Anderson, K. (2017) 'Convergence in National Alcohol Consumption Patterns: New Global Indicators', Journal of Wine Economics, 12(2), pp. 117–148. Available at: https://doi.org/10.1017/jwe.2017.15.

Huse, O. et al. (2022) 'The nutrition transition, food retail transformations, and policy responses to overnutrition in the East Asia region: A descriptive review', Obesity Reviews, 23(4), p. e13412. Available at: https://doi.org/10.1111/obr.13412.

Institute for Health Metrics and Evaluation (2024) 'Global Burden of Disease Study 2021 (GBD 2021)'. Seattle, United States. Available at: https://www.healthdata.org/research-analysis/gbd (Accessed: 15 August 2025).

Kapur, A. and Harries, A.D. (2013) 'The double burden of diabetes and tuberculosis – Public health implications', Diabetes Research and Clinical Practice, 101(1), pp. 10–19. Available at: https://doi.org/10.1016/j.diabres.2012.12.001.

Keenan, L., Monteath, T. and Wójcik, D. (2023) 'Hungry for power: financialization and the concentration of corporate control in the global food system', Geoforum, 147, p. 103909. Available at: https://doi.org/10.1016/j.geoforum.2023.103909.

Key, T.J. et al. (2004) 'Diet, nutrition and the prevention of cancer', Public Health Nutrition, 7(1A), pp. 187–200. Available at: https://doi.org/10.1079/phn2003588.

Kwok, A. et al. (2019) 'Effect of alcohol consumption on food energy intake: a systematic review and meta-analysis', British Journal of Nutrition, 121(5), pp. 481–495. Available at: https://doi.org/10.1017/S0007114518003677.

Lara-Castor, L. et al. (2025) 'Burdens of type 2 diabetes and cardiovascular disease attributable to sugar-sweetened beverages in 184 countries', Nature Medicine, 31(2), pp. 552–564. Available at: https://doi.org/10.1038/s41591-024-03345-4.

Li, Z. et al. (2022) 'Temporal trends in the burden of non-communicable diseases in countries with the highest malaria burden, 1990–2019: Evaluating the double burden of non-communicable and communicable diseases in epidemiological transition', Globalization and Health, 18(1), p. 90. Available at: https://doi.org/10.1186/s12992-022-00882-w.

Lopez, A.D. et al. (2014) 'Remembering the forgotten non-communicable diseases', BMC Medicine, 12(1), p. 200. Available at: https://doi.org/10.1186/s12916-014-0200-8.

MacKillop, J. et al. (2022) 'Hazardous drinking and alcohol use disorders', Nature reviews. Disease primers, 8(1), p. 80. Available at: https://doi.org/10.1038/s41572-022-00406-1.

Maiyaki, M. and Garbati, M. (2014) 'The burden of non-communicable diseases in Nigeria; in the context of globalization', Annals of African Medicine, 13(1), p. 1. Available at: https://doi.org/10.4103/1596-3519.126933.

Manthey, J. et al. (2019) 'Global alcohol exposure between 1990 and 2017 and forecasts until 2030: a modelling study', Lancet (London, England), 393(10190), pp. 2493–2502. Available at: https://doi.org/10.1016/S0140-6736(18)32744-2.

Marshall, Q. et al. (2021) 'Building a Global Food Systems Typology: A New Tool for Reducing Complexity in Food Systems Analysis', Frontiers in Sustainable Food Systems, 5, p. 746512. Available at: https://doi.org/10.3389/fsufs.2021.746512.

McClain, C.J. et al. (2021) 'Malnutrition and Alcohol-Associated Hepatitis', Clinics in liver disease, 25(3), pp. 557–570. Available at: https://doi.org/10.1016/j.cld.2021.03.002.

Morojele, N.K. et al. (2021) 'Alcohol consumption, harms and policy developments in sub-Saharan Africa: The case for stronger national and regional responses', Drug and Alcohol Review, 40(3), pp. 402–419. Available at: https://doi.org/10.1111/dar.13247.

Moyo-Chilufya, M. et al. (2023) 'The burden of non-communicable diseases among people living with HIV in Sub-Saharan Africa: a systematic review and meta-analysis', eClinicalMedicine, 65. Available at: https://doi.org/10.1016/j.eclinm.2023.102255.

Olshansky, S.J. and Ault, A.B. (1986) 'The fourth stage of the epidemiologic transition: the age of delayed degenerative diseases', The Milbank Quarterly, 64(3), pp. 355–391.

Omran, A.R. (1971) 'The epidemiologic transition. A theory of the epidemiology of population change', The Milbank Memorial Fund Quarterly, 49(4), pp. 509–538.

Oxford English Dictionary (2008) food, n. meanings, etymology and more. Available at: https://www.oed.com/dictionary/food_n (Accessed: 12 June 2025).

Pallangyo, P. et al. (2020) 'Obesity epidemic in urban Tanzania: a public health calamity in an already overwhelmed and fragmented health system', BMC Endocrine Disorders, 20(1), p. 147. Available at: https://doi.org/10.1186/s12902-020-00631-3.

Parry, C.D.H. (2000) 'Alcohol Problems in Developing Countries: Challenges for the New Millennium', Suchtmed, 2 (4), pp. 216–220.

Pettigrew, S. et al. (2025) '"There's just a lot of numbers and I just want to have a drink": The challenge of communicating the energy content of alcohol products', Appetite, 205, p. 107700. Available at: https://doi.org/10.1016/j.appet.2024.107700.

Popkin, B.M. (1993) 'Nutritional Patterns and Transitions', Population and Development Review, 19(1), pp. 138–157. Available at: https://doi.org/10.2307/2938388.

Popkin, B.M. (2001) 'The Nutrition Transition and Obesity in the Developing World', The Journal of Nutrition, 131(3), pp. 871S-873S. Available at: https://doi.org/10.1093/jn/131.3.871S.

Popkin, B.M. (2002) 'An overview on the nutrition transition and its health implications: the Bellagio meeting', Public Health Nutrition, 5(1A), pp. 93–103. Available at: https://doi.org/10.1079/phn2001280.

Popkin, B.M. (2006) 'Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases', The American Journal of Clinical Nutrition, 84(2), pp. 289–298. Available at: https://doi.org/10.1093/ajcn/84.2.289.

Popkin, B.M. (2007) 'Understanding global nutrition dynamics as a step towards controlling cancer incidence', Nature Reviews. Cancer, 7(1), pp. 61–67. Available at: https://doi.org/10.1038/nrc2029.

Popkin, B.M. (2015) 'Nutrition Transition and the Global Diabetes Epidemic', Current Diabetes Reports, 15(9), p. 64. Available at: https://doi.org/10.1007/s11892-015-0631-4.

Popkin, B.M. (2017) 'Relationship between shifts in food system dynamics and acceleration of the global nutrition transition', Nutrition Reviews, 75(2), pp. 73–82. Available at: https://doi.org/10.1093/nutrit/nuw064.

Popkin, B.M., Adair, L.S. and Ng, S.W. (2012) 'Global nutrition transition and the pandemic of obesity in developing countries', Nutrition Reviews, 70(1), pp. 3–21. Available at: https://doi.org/10.1111/j.1753-4887.2011.00456.x.

Popkin, B.M., Corvalan, C. and Grummer-Strawn, L.M. (2020) 'Dynamics of the double burden of malnutrition and the changing nutrition reality', Lancet (London, England), 395(10217), pp. 65–74. Available at: https://doi.org/10.1016/S0140-6736(19)32497-3.

Popkin, B.M. and Gordon-Larsen, P. (2004) 'The nutrition transition: worldwide obesity dynamics and their determinants', International Journal of Obesity, 28(S3), pp. S2–S9. Available at: https://doi.org/10.1038/sj.ijo.0802804.

Popkin, B.M. and Ng, S.W. (2022) 'The nutrition transition to a stage of high obesity and noncommunicable disease prevalence dominated by ultra-processed foods is not inevitable', Obesity Reviews, 23(1), p. e13366. Available at: https://doi.org/10.1111/obr.13366.

Poznyak, V. et al. (2014) 'The World Health Organization's Global Monitoring System on Alcohol and Health', Alcohol Research : Current Reviews, 35(2), pp. 244–249.

Probst, C., Manthey, J. and Rehm, J. (2017) 'Understanding the prevalence of lifetime abstinence from alcohol: An ecological study', Drug and Alcohol Dependence, 178, pp. 126–129. Available at: https://doi.org/10.1016/j.drugalcdep.2017.05.008.

'R: The R Project for Statistical Computing' (2023). Available at: https://www.r-project.org/ (Accessed: 24 July 2025).

Rayner, M. et al. (2017) An Introduction to Population-level Prevention of Non-Communicable Diseases. Oxford: OUP Oxford.

Reardon, T. et al. (2021) 'The processed food revolution in African food systems and the double burden of malnutrition', Global Food Security, 28, p. 100466. Available at: https://doi.org/10.1016/j.gfs.2020.100466.

Rehm, J. et al. (2009) 'The association between alcohol use, alcohol use disorders and tuberculosis (TB). A systematic review', BMC Public Health, 9(1), p. 450. Available at: https://doi.org/10.1186/1471-2458-9-450.

Rehm, J. et al. (2017) 'The relationship between different dimensions of alcohol use and the burden of disease-an update', Addiction (Abingdon, England), 112(6), pp. 968–1001. Available at: https://doi.org/10.1111/add.13757.

Rehm, J. et al. (2018) 'Alcohol dependence and very high risk level of alcohol consumption: a life-threatening and debilitating disease', Addiction Biology, 23(4), pp. 961–968. Available at: https://doi.org/10.1111/adb.12646.

Ronto, R., Wu, J.H. and Singh, G.M. (2018) 'The global nutrition transition: trends, disease burdens and policy interventions', Public Health Nutrition, 21(12), pp. 2267–2270. Available at: https://doi.org/10.1017/S1368980018000423.

Rossi, M. et al. (2018) 'Colorectal Cancer and Alcohol Consumption—Populations to Molecules', Cancers, 10(2), p. 38. Available at: https://doi.org/10.3390/cancers10020038.

Rousham, E.K. et al. (2020) 'Dietary behaviours in the context of nutrition transition: a systematic review and meta-analyses in two African countries', Public Health Nutrition, 23(11), pp. 1948–1964. Available at: https://doi.org/10.1017/S1368980019004014.

Rovira, P. and Rehm, J. (2021) 'Estimation of cancers caused by light to moderate alcohol consumption in the European Union', European Journal of Public Health, 31(3), pp. 591–596. Available at: https://doi.org/10.1093/eurpub/ckaa236.

Shield, K., Manthey, J., Rylett, M., Probst, C., Wettlaufer, A., Parry, Charles D H, et al. (2020) 'National, regional, and global burdens of disease from 2000 to 2016 attributable to alcohol use: a comparative risk assessment study', The Lancet Public Health, 5(1), pp. e51–e61. Available at: https://doi.org/10.1016/S2468-2667(19)30231-2.

Shrimpton, R. and Rokx, C. (2012) The Double Burden of Malnutrition: A Review of Global Evidence. Nutrition and Population Discussion Paper. World Bank.

Simpson, R.F. et al. (2019) 'Alcohol drinking patterns and liver cirrhosis risk: analysis of the prospective UK Million Women Study', The Lancet Public Health, 4(1), pp. e41–e48. Available at: https://doi.org/10.1016/S2468-2667(18)30230-5.

Swinburn, B.A. et al. (2004) 'Diet, nutrition and the prevention of excess weight gain and obesity', Public Health Nutrition, 7(1A), pp. 123–146. Available at: https://doi.org/10.1079/phn2003585.

Tanaka, S. et al. (2014) 'Non-communicable Diseases: Global epidemics; global determinants; global solutions? Towards a healthy role for transnational food, beverage and alcohol industries in the global governance of noncommunicable disease risk', in. Discussion on 'Private authority and public health', UCL.

Ubago-Guisado, E. et al. (2021) 'Evidence Update on the Relationship between Diet and the Most Common Cancers from the European Prospective Investigation into Cancer and Nutrition (EPIC) Study: A Systematic Review', Nutrients, 13(10), p. 3582. Available at: https://doi.org/10.3390/nu13103582.

United Nations (2015) Targets of Sustainable Development Goal 3. Available at: https://www.who.int/europe/about-us/our-work/sustainable-development-goals/targets-of-sustainable-development-goal-3 (Accessed: 8 August 2025).

Viana, R.S. et al. (2024) 'Prevalence of the Double Burden of Malnutrition among Adolescents: Associations with Lifestyle Behaviors and Clusters of Social Determinants', Children, 11(6), p. 620. Available at: https://doi.org/10.3390/children11060620.

Vorster, H.H., Kruger, A. and Margetts, B.M. (2011) 'The Nutrition Transition in Africa: Can It Be Steered into a More Positive Direction?', Nutrients, 3(4), pp. 429–441. Available at: https://doi.org/10.3390/nu3040429.

Walls, H. et al. (2020) 'Advancing alcohol research in low-income and middle-income countries: a global alcohol environment framework', BMJ Global Health, 5(4). Available at: https://doi.org/10.1136/bmjgh-2019-001958.

Wickham, H. et al. (2019) 'Welcome to the Tidyverse', Journal of Open Source Software, 4(43), p. 1686. Available at: https://doi.org/10.21105/joss.01686.

World Health Organization (2017) Double-duty actions for nutrition. Policy Brief. Geneva.

World Health Organization (2023) A PUBLIC HEALTH PERSPECTIVE ON ZERO-AND LOWALCOHOL BEVERAGES. BRIEF 10, 2023. Geneva.

World Health Organization (2024b) Alcohol. Available at: https://www.who.int/news-room/fact-sheets/detail/alcohol (Accessed: 15 August 2025).

World Health Organization (2024a) Global status report on alcohol and health and treatment of substance use disorders. Geneva.

World Health Organization (2025) Global Health Observatory. Available at: https://www.who.int/data/gho (Accessed: 15 August 2025).

World Health Organization and Lancet (2023) No level of alcohol consumption is safe for our health. Available at: https://www.who.int/europe/news/item/04-01-2023-no-level-of-alcohol-consumption-is-safe-for-our-health (Accessed: 19 July 2025).

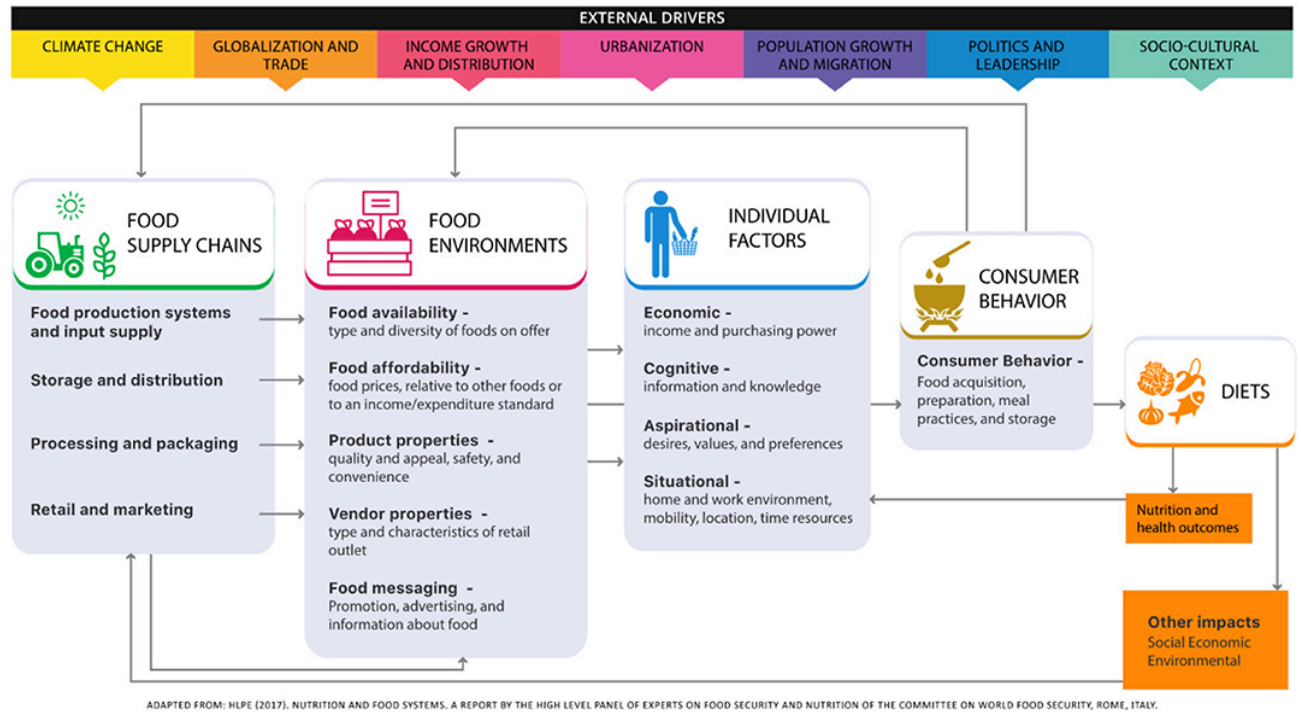
9. Appendix

Appendix 1. Source, date of retrieval, and countries included in Food Systems Typology and Figures 2-6.

	1. Rural & Traditional	2. Informal & Expanding	3. Emerging & Diversifying	4. Modernising & Formalising	5. Industrialised & Consolidated	Source	Date retrieved
Food Systems Typology: countries included.	Afghanistan	Angola	Bosnia and Herzegovina	Albania	Argentina	Marshall et al., 2021	19/05/2025
	Benin	Azerbaijan	Belize	United Arab Emirates	Australia		
	Burkina Faso	Bolivia	Botswana	Bulgaria	Austria		
	Bangladesh	Cote dIvoire	China	Belarus	Belgium		
	Central African Republic	Cameroon	Cape Verde	Brazil	Bahamas		
	Ethiopia	Congo	Cuba	Chile	Canada		
	Guinea	Egypt	Algeria	Colombia	Switzerland		
	Guinea-Bissau	Ghana	Ecuador	Costa Rica	Cyprus		
	India	Guatemala	Fiji	Dominican Republic	Czech Republic		
	Kenya	Honduras	Gabon	Croatia	Germany		
	Cambodia	Haiti	Georgia	Ireland	Denmark		
	Lao PDR	Indonesia	Guyana	Iran	Spain		
	Liberia	Iraq	Jamaica	Jordan	Estonia		
	Lesotho	Kyrgyzstan	Kazakhstan	Korea Rep	Finland		
	Madagascar	Sri Lanka	Lebanon	Kuwait	France		
	Mali	Morocco	Saint Lucia	Lithuania	United Kingdom		
	Mozambique	Myanmar	Republic of Moldova	Latvia	Greece		
	Malawi	Mauritania	Maldives	Macedonia	Hong Kong SAR		
	Niger	Namibia	Mexico	Montenegro	Hungary		
	Nepal	Nigeria	Mauritius	Mongolia	Iceland		
	Pakistan	Nicaragua	Panama	Malaysia	Israel		
	Rwanda	Peru	Paraguay	Oman	Italy		
	Sierra Leone	Philippines	Romania	Poland	Japan		
	Chad	Sudan	El Salvador	Portugal	Luxembourg		
	Togo	Senegal	Serbia	Russian Federation	Malta		
	Tajikistan	Swaziland	Turkmenistan	Saudi Arabia	Netherlands		
	Tanzania	Thailand	Trinidad and Tobago	Suriname	Norway		
	Yemen	Uganda	Tunisia	Slovakia	New Zealand		

	Zambia Zimbabwe	Uzbekistan Vietnam Vanuatu	Ukraine St Vincent and the Grenadines Samoa South Africa	Slovenia Turkey Venezuela	Sweden Uruguay United States Of America		
Figure 2. Daily calorie supply (kcal/capita/day) a) in total, and from b) animal products, c) sugar & sweeteners, d) vegetable oils, and e) alcoholic beverages in 155 countries aggregated by food systems type	Missing (0)	Missing (0)	Missing (0)	Missing (0)	Missing (0)	FAOSTAT	16/05/2025
Figure 3. Annual pure alcohol consumption in drinkers only (litres/capita, 3-year averages) in 152 countries aggregated by food system type, 2000-2020.	Missing (0)	Missing (0)	Missing (1): Serbia	Missing (1): Montenegro	Missing (1): China, Hong Kong SAR	WHO Global Health Observatory	23/05/2025
Figure 4. Proportion of the adult population (15+ years) reporting abstinence from consuming alcohol over the last 12 months, abstaining from drinking alcohol in 154 countries, aggregated by food system type, 2000-2020	Missing (0)	Missing (0)	Missing (0)	Missing (0)	Missing (1): China, Hong Kong SAR	WHO Global Health Observatory	23/05/2025
Figure 5. Percentage of drinkers reporting heavy episodic drinking (>60g pure alcohol on at least one occasion over the last 30 days) in 154 countries aggregated by food system type, 2000-2020	Missing (0)	Missing (0)	Missing (0)	Missing (0)	Missing (1): China, Hong Kong SAR	WHO Global Health Observatory	23/05/2025
Figure 6. Death rate attributed to dietary risks, high alcohol use, and low physical activity in 154 countries aggregated by food system type, 2019.	Missing (0)	Missing (0)	Missing (0)	Missing (0)	Missing (1): China, Hong Kong SAR	GBD	31/07/2025

Appendix 2. Conceptual framework for food systems. (Marshall et al., 2021).



Appendix 3.Percentage of total kcal supply from a) animal products, b) sugar & sweeteners, c) vegetable oils, and d) alcoholic beverages in 154 countries aggregated by FST, 1961-2022.