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«ΤΕΧΝΟ-ΟΙΚΟΝΟΜΙΚΑ ΣΥΣΤΗΜΑΤΑ»

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Effects of green urban regeneration on chronic disease patients

ΜΕΤΑΠΤΥΧΙΑΚΗ ΔΙΠΛΩΜΑΤΙΚΗ ΕΡΓΑΣΙΑ

Στυλιανή Ν. Αμιραλή

Επιβλέπων : Αναστάσιος Δουλάμης
Καθηγητής ΕΜΠ

Αθήνα, Ιούνιος 2025

Styliani N. Amirali

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Εγκρίθηκε από την τριμελή εξεταστική επιτροπή την 30η Ιουνίου 2025.

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Αθήνα, Ιούνιος 2025

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Απαγορεύεται η αντιγραφή, αποθήκευση και διανομή της παρούσας εργασίας, εξ ολοκλήρου ή τμήματος αυτής, για εμπορικό σκοπό. Επιτρέπεται η ανατύπωση, αποθήκευση και διανομή για σκοπό μη κερδοσκοπικό, εκπαιδευτικής ή ερευνητικής φύσης, υπό την προϋπόθεση να αναφέρεται η πηγή προέλευσης και να διατηρείται το παρόν μήνυμα. Ερωτήματα που αφορούν τη χρήση της εργασίας για κερδοσκοπικό σκοπό πρέπει να απευθύνονται προς τον συγγραφέα.

Οι απόψεις και τα συμπεράσματα που περιέχονται σε αυτό το έγγραφο εκφράζουν τον συγγραφέα και δεν πρέπει να ερμηνευθεί ότι αντιπροσωπεύουν τις επίσημες θέσεις του Εθνικού Μετσόβιου Πολυτεχνείου.

Abstract

This body of work consists of a literary overview on the latest conditions of chronic disease, on the trend of urban area greening policies and the effect of the latter on chronic disease patients. Chronic illnesses are affecting a greater percentage of the ever-aging population. Urbanization is a modern human life formation that is prevalent in all large economies and progressively concerns larger populations worldwide. Urbanization though is linked with various risk factors for chronic disease. Green spaces in urban environments are proven to have beneficiary effects on the general population's health, and hence on chronic disease patients. More funding is needed to verify the exact correlation between specific characteristics of green space and the effects on human health, as well as to the expansion and amelioration of existing green spaces in urban environment.

Key Words: urban settlements, urban environment, urbanization, chronic diseases, health risks, green spaces, green regeneration, green policies

Περίληψη

Το παρόν έργο αποτελεί βιβλιογραφική επισκόπηση επί των σημερινών όρων των χρόνιων νοσημάτων, της τάσης αύξησης του αστικού πρασίνου και της επίδρασης που έχει το τελευταίο στην υγεία των χρονίως πασχόντων. Τα χρόνια νοσήματα επηρεάζουν μεγάλο κομμάτι του γηράσκοντος πληθυσμού. Η αστικοποίηση ως κυρίαρχος σχηματισμός οργάνωσης της ζωής σε όλες τις μεγάλες οικονομίες, αφορά σταδιακά ολοένα και μεγαλύτερα τμήματα του πληθυσμού παγκοσμίως. Η αστικοποίηση όμως είναι συνδεδεμένη με διάφορους παράγοντες κινδύνου για χρόνια νοσήματα. Οι χώροι πρασίνου στο αστικό περιβάλλον έχουν συνδεθεί με θετικές επιδράσεις στην υγεία του γενικού πληθυσμού και, κατ' επέκταση, στους χρονίως πάσχοντες. Χρειάζεται μεγαλύτερη χρηματοδότηση αφενός για να εξακριβωθεί η ακριβής συσχέτιση μεταξύ συγκεκριμένων χαρακτηριστικών των χώρων πρασίνου που επηρεάζουν την υγεία, και αφετέρου για να επεκταθούν και να βελτιωθούν οι υπάρχοντες χώροι πρασίνου στις πόλεις.

Λέξεις κλειδιά: αστικό περιβάλλον, αστικοποίηση, χρόνιες παθήσεις, πράσινη ανάπλαση, πράσινες πολιτικές

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Εκτεταμένη Ελληνική Περίληψη

Αν και τα χρόνια νοσήματα δεν ήταν άγνωστα στους ανθρώπους των περασμένων αιώνων, ποτέ στο παρελθόν δεν αφορούσαν το πλήθος των ανθρώπων σε απόλυτους και σχετικούς αριθμούς που αφορούν τους τελευταίους δύο αιώνες. Ομοίως δεν απασχολούσαν όσους πόρους απασχολούν τώρα σε σχετικούς και απόλυτους αριθμούς. Συγκεκριμένα, σύμφωνα με τον Παγκόσμιο Οργανισμό Υγείας (ΠΟΥ) περίπου το 1/3 του παγκόσμιου πληθυσμού υποφέρει από κάποια χρόνια ασθένεια, και συνολικά τα χρόνια νοσήματα ευθύνονται για το 38% του συνόλου των θανάτων παγκοσμίως.

Αναλύοντας τα ιστορικά δεδομένα εξάπλωσης και τελικά εδραίωσης των χρόνιων νοσημάτων, φαίνεται πως αρχικά αφορούσαν κυρίως τις Δυτικές χώρες (Ευρώπη, Βόρεια Αμερική κ.α.) ενώ πλέον αφορούν και τις υπόλοιπες Ηπείρους, ειδικά αυτές που διανύουν περίοδο βιομηχανικής ανάπτυξης όπως η Νοτιοανατολική Ασία. Παρατηρείται επίσης το φαινόμενο τα χρόνια νοσήματα να επιβαρύνουν δυσανάλογα τα κατώτερα οικονομικά στρώματα και τους ανθρώπους άνω των 60 ετών, αν και παρατηρείται η τάση αύξησης του οικονομικά ενεργού πληθυσμού που συνεχίζει να εργάζεται αν και έχει εμφανίσει κάποια χρόνια ασθένεια.

Για να ερμηνευτεί η ανοδική τάση εμφάνισης και εδραίωσης χρόνιων νοσημάτων στον πληθυσμό, έχει νόημα να μελετηθεί η εξέλιξη των παραγόντων κινδύνου που έχουν συνδεθεί με την εμφάνιση των χρόνιων νοσημάτων. Πρωταρχικός παράγοντας κινδύνου είναι το αυξημένο προσδόκιμο ζωής, καθώς οι άνθρωποι σήμερα ζουν περισσότερο από κάθε άλλη προηγούμενη ιστορική περίοδο, με αποτέλεσμα να εμφανίζουν κληρονομικές ασθένειες και φυσιολογικό εκφυλισμό του σώματος που στο παρελθόν δύσκολα θα προλάβαιναν να βιώσουν. Σε αυτή την επισκόπηση όμως, θα επικεντρωθούμε στην μελέτη των τροποποιήσιμων παραγόντων κινδύνου για τη μακροχρόνια υγεία.

Σε αδρές γραμμές, οι παράγοντες κινδύνου μπορούν να διακριθούν σε δύο κατηγορίες: τους συμπεριφορικούς και τους περιβαλλοντικούς. Ως συμπεριφορικούς ορίζουμε τους παράγοντες που αφορούν σε προσωπικές επιλογές του τρόπου ζωής των ατόμων ως προς τις διατροφικές συνήθειες, την ψυχαγωγία και την άσκηση. Συμπεριφορές όπως το κάπνισμα, η κατανάλωση αλκοόλ, ναρκωτικών, η παχυσαρκία και η καθιστική ζωή επιβαρύνουν τον οργανισμό και συνδέονται με αυξημένη πιθανότητα εμφάνισης κάποιου χρόνιου νοσήματος, όπως οι πνευμονοπάθειες, τα καρδιαγγειακά νοσήματα, ο διαβήτης, πολλές μορφές καρκίνου και άλλα. Τις τελευταίες δεκαετίες παρατηρείται μείωση στην κατανάλωση αλκοόλ και στη χρήση καπνού αλλά αύξηση στα ποσοστά παχυσαρκίας και κατανάλωσης ναρκωτικών.

Ως περιβαλλοντικούς παράγοντες κινδύνου ορίζουμε αυτούς που δεν εξαρτώνται από τις ατομικές επιλογές του πολίτη, αλλά τις υφίσταται λόγω του περιβάλλοντος στο οποίο ζει. Τέτοιοι είναι η μόλυνση του νερού και του αέρα, η ηχορύπανση και το εργασιακό μοντέλο που ακολουθείται σε μία χώρα. Τα στοιχεία των τελευταίων δεκαετιών δείχνουν μείωση των επιπέδων μόλυνσης του νερού και του αέρα στις Δυτικές χώρες, αλλά αύξηση της μόλυνσης σε χώρες της Αφρικής και της Ασίας όπου επικεντρώνεται μεγάλο κομμάτι της παγκόσμιας βιομηχανικής παραγωγής. Αντίστοιχη είναι η εικόνα αναφορικά με τα στοιχεία ηχορύπανσης, ενώ το εργασιακό μοντέλο φαίνεται να επιδεινώνεται διεθνώς με αύξηση των ορίων συνταξιοδότησης, αύξηση των εργάσιμων ωρών και της εργασιακής επισφάλειας, συσσωρεύοντας στρεσογενείς φλεγμονές στον οργανισμό.

Αποτέλεσμα της εκδήλωσης χρόνιων νοσημάτων είναι αφενός η μεγάλη οικονομική και προσωπική επιβάρυνση των νοικοκυριών που ανήκει ο χρονίως πάσχοντας και αφετέρου η μεγάλη δημοσιονομική δαπάνη των δημόσιων δομών υγείας, δεδομένου ότι εν πολλοίς απουσιάζει το ολιστικό μοντέλο προσέγγισης των χρόνιων νοσημάτων. Η παρούσα προσέγγιση των ιατρικών περιστατικών είναι καλύτερα προσαρμοσμένη στην αντιμετώπιση οξέων περιστατικών και μεταδοτικών ασθενειών, παραβλέποντας τις ιδιαίτερες ανάγκες των χρονίως πασχόντων οι οποίοι χρειάζονται μακροχρόνια συμβουλευτική, υποστήριξη από περισσότερες ειδικότητες και στενότερη παρακολούθηση για μεγάλο χρονικό διάστημα μετά την εμφάνιση οξέος συμπτώματος.

Εκτός από την αποτελεσματικότερη στροφή του συστήματος υγείας προς τους χρονίως πάσχοντες, άλλα μέτρα αποτελεσματικής αντιμετώπισης του φαινομένου είναι οι καμπάνιες ενημέρωσης των πολιτών σχετικά με τους παράγοντες κινδύνου για τα χρόνια νοσήματα, η προώθηση υγιεινού τρόπου ζωής και τα μέτρα περιορισμού των περιβαλλοντικών παραγόντων κινδύνου.

Αν και οι παράγοντες κινδύνου που αναφέραμε είναι παρόντες τόσο στις πόλεις όσο και στην ύπαιθρο, αφενός οι πόλεις συγκεντρώνουν σύμφωνα με εκτιμήσεις το 80% του παγκόσμιου πληθυσμού, κι επομένως αφορούν εξ' ορισμού την πλειοψηφία του παγκόσμιου πληθυσμού, και αφετέρου η αύξηση της αστικοποίησης φαίνεται να συμβαδίζει με την αύξηση των χρόνιων ασθενειών στον πληθυσμό. Συνεπώς έχει σημασία να μελετηθεί ιδιαίτερα το αστικό περιβάλλον στην υπόθαλψη των παραγόντων κινδύνου για χρόνιες ασθένειες.

Η ύπαρξη πόλεων καταγράφεται από την αρχαιότητα, αλλά ποτέ δεν είχαν την οικονομική και πληθυσμιακή σημασία που έχουν τους τελευταίους δύο αιώνες. Παρά τις επιμέρους εθνικές διαφοροποιήσεις ως προς τον ορισμό του αστικού περιβάλλοντος, το 2020 ο ΟΗΕ συμφώνησε στον ορισμό συγκεκριμένης πληθυσμιακής πυκνότητας ανά τετραγωνικό χιλιόμετρο για τον χαρακτηρισμό μίας περιοχής ως αστικής ή μη αστικής. Βάσει του συγκεκριμένου ορισμού και των δορυφορικών εικόνων του συστήματος Copernicus τεκμαίρεται πως το 80% του παγκόσμιου πληθυσμού διαμένει σε αστικό περιβάλλον, ποσοστό που αναμένεται να αυξηθεί ακόμα περισσότερο τα προσεχή χρόνια.

Ιδιαίτερο ενδιαφέρον παρουσιάζει η ομοιογένεια προς την οποία συγκλίνουν όλες οι πτυχές της ζωής των ανθρώπων που ζουν σε αστικά περιβάλλοντα ανεξάρτητα από τη συγκεκριμένη γεωγραφική τοποθεσία στην οποία βρίσκονται. Έτσι ο τρόπος ζωής και οι διαθέσιμες επιλογές για διατροφή, ψυχαγωγία, εργασία, στέγαση κ.ο.κ. τείνουν να ταυτίζονται σε βαθμό που δεν έχει επαναληφθεί στην ανθρώπινη ιστορία. Φυσικά αυτό επηρεάζει και την παρουσία των παραγόντων κινδύνου για χρόνιες παθήσεις.

Ορισμένα φαινόμενα που επιβαρύνουν την υγεία και εμφανίζονται αποκλειστικά σε αστικές περιοχές είναι το φαινόμενο του αστικού φαραγγιού κατά το οποίο το σχέδιο πόλης των ανεγερμένων κτηρίων επηρεάζει την ποιότητα του αέρα και τη θερμοκρασία μίας περιοχής, το φαινόμενο της αστικής θερμικής νήσου κατά το οποίο τα υλικά κατασκευής των ανεγερμένων κτηρίων σε συνδυασμό με την απουσία πρασίνου αυξάνουν για αρκετούς βαθμούς την ατμοσφαιρική θερμοκρασία τοπικά, η διαχείριση των λυμάτων και των απορριμμάτων που μπορεί να γίνει σημαντική πηγή μόλυνσης, και η δυσκολία κυκλοφορίας των πεζών σε συνδυασμό με την εντατική χρήση ιδιωτικών οχημάτων.

Τις τελευταίες δύο δεκαετίες έχουν κινητοποιηθεί μεγάλα ποσά προς την κατεύθυνση της πράσινης ανάπτυξης, ιδιαίτερα στις πιο ισχυρές οικονομίες. Μέρος αυτών των χρημάτων έχει κατευθυνθεί προς τη χρηματοδότηση πράσινων αναπλάσεων στα αστικά κέντρα με στόχο τη βιωσιμότητα και την ενεργειακή ανθεκτικότητα. Τέτοιες παρεμβάσεις περιλαμβάνουν από την φύτευση δέντρων στα διαζώματα των αυτοκινητοδρόμων, μέχρι τα πάρκα τσέπης και τη φύτευση κήπων σε ταράτσες. Βέβαια παρά τις όποιες επιμέρους βελτιώσεις στα ποσοστά πράσινης κάλυψης ορισμένων πόλεων ανά τον κόσμο, παραμένει γεγονός ότι η συνολική έκταση του πρασίνου στις αστικές περιοχές βαίνει μειούμενη και ακόμα και κραταιές ευρωπαϊκές πρωτεύουσες αδυνατούν να παρέχουν στους πολίτες τους τη συνιστώμενη ποσότητα πρασίνου που θα τους προσφέρει ευεξία και συνολικά καλή υγεία σύμφωνα με τον Παγκόσμιο Οργανισμό Υγείας.

Παράλληλα με τις πράσινες επενδύσεις, έχουν αυξηθεί οι πανεπιστημιακές έρευνες που προσπαθούν να συνδέσουν την παρουσία πρασίνου με θετική επίδραση στην υγεία των κατοίκων των πόλεων. Αυτές οι έρευνες αντιμετωπίζουν σοβαρούς περιορισμούς ως προς την αξιοπιστία των ευρημάτων τους, στον βαθμό που δεν μπορούν να διαχωρίσουν τις θετικές επιδράσεις του πρασίνου από του απλώς ανοιχτού χώρου ή του προσβάσιμου στο κοινό πρασίνου σε σχέση με τη συνολική έκταση πρασίνου, ή τις διαφοροποιήσεις στην επίδραση διαφορετικών χαρακτηριστικών βλάστησης.

Παρ’ όλα αυτά διαφαίνεται μια θετική συσχέτιση μεταξύ της παρουσίας αστικού πρασίνου και της γενικότερης υγείας του πληθυσμού που το απολαμβάνει. Συγκεκριμένα παρατηρούνται καλύτεροι βιομετρικοί δείκτες, καλύτερη πνευματική κατάσταση και μειωμένες πιθανότητες εμφάνισης και θανάτου από χρόνια και εκφυλιστικά νοσήματα για τους κατοίκους που έρχονται συχνά σε επαφή με χώρους πρασίνου.

Η ως άνωθεν περιγραφόμενη συσχέτιση οφείλεται τόσο στην άμεση επαφή με το πράσινο και τις ιδιαίτερες εκφάνσεις του, όσο και σε έμμεσες αιτίες που υποκρύπτει η παρουσία του πρασίνου, όπως η απουσία βιομηχανικών και οδικών δραστηριοτήτων που οδηγεί σε καλύτερη ποιότητα αέρα και λιγότερη ηχορύπανση, η τοπική μείωση της θερμοκρασίας ειδικά σε περιόδους καύσωνα, η πλαισίωση χώρων κατάλληλων για κοινωνικές συναθροίσεις κ.α.

Ως πρόταση πολιτικής για τα επόμενα χρόνια θα προτεινόταν η ένταση της χρηματοδότησης τόσο στην έρευνα ανίχνευσης των συγκεκριμένων επιδράσεων των διαφόρων χαρακτηριστικών των αστικών χώρων πρασίνου σε διάφορους δείκτες υγείας, αλλά και στην περαιτέρω ανάπτυξη των αστικών χώρων πρασίνου, είτε με τη δημιουργία νέων είτε με την ποιοτική αποκατάσταση των ήδη υπαρχόντων οι οποίοι σε πολλές περιπτώσεις δεν είναι ελκυστικοί για τους κατοίκους.

Αν και οι θετικές επιδράσεις όπως έχουν καταγραφεί ως τώρα δεν αποτυπώνονται στο σύνολο των υπό μελέτη ανθρώπων αλλά ούτε υπονοείται πως θα μπορούσαν να αντικαταστήσουν τις παραδοσιακές ιατροφαρμακευτικές προσεγγίσεις, θα μπορούσαν σίγουρα να μετριάσουν το μεγάλο οικονομικό και κοινωνικό βάρος που προκύπτει από τις χρόνιες ασθένειες, είτε συνδράμοντας στην προληπτική δράση απέναντί τους, είτε προσφέροντας ανακούφιση αφού αυτές έχουν εκδηλωθεί.

1) Introduction

Chronic disease in its many forms is tending to become the main cause of death worldwide. According to data provided by the World Health Organization (WHO), chronic diseases are the cause of 74% of all non-pandemic-related deaths worldwide.[1] Notably, that fact implies also the disability-adjusted life years (DALYs) that reduce the patients' quality of life and productivity, as well as constantly increasing the private and public expenses of treatment for such chronic conditions. One can liken chronic diseases to a modern epidemic.

Healthcare agents suggest that for a more efficient battle with chronic disease, the healthcare system should change orientation from intensive hospital-centered care units, that fight mostly the symptoms of the chronic disease, to primary healthcare units and general medicine to help prevent the manifestation of chronic diseases as well as to help with management and post-disease care to prevent the resurgence of the disease. Additionally, this approach is said to be more cost effective in the long term than the one used already.

Numerous scientists have emphasized through the years that modern urban living has favored various health risks -both habitual and environmental- which are associated with rising trends in chronic diseases. Green regeneration of urban settings has also provided evidence of counteraction towards the known health risk factors of cities. That acknowledgement is a contributory force for the ongoing shift towards 'greening' public spaces in large cities worldwide (e.g. the EU Green Deal plans on greening public spaces).[2]

Under this holistic approach to general medicine, we will dive into the urban conditions of living, the risk factors to chronic disease that this way of living insinuates and the beneficiary effects of urban green spaces. Urban green spaces are recognized as an interactive lifestyle change to people already suffering from chronic disease and as a preventive measure to chronic disease from the general population.

2) The present status of chronic diseases

As disease we define an abnormal condition that affects the structure or function of part or whole of the body and is usually associated with specific signs and symptoms.[3] In the 21st century, we accept as a fact that many deadly acute diseases are eradicated and even eliminated, as smallpox, by modern scientific medical practices such as sanitation and vaccination (prevention), and antibiotics (treatment). That can be confirmed from the steep decrease in infants' mortality rate and the subsequent population growth and lifetime expectancy around the globe in the last two centuries.

Another suggestion is that together with the overall rise in life expectancy and general population, also chronic diseases have risen and now make up the main part of healthcare expenses.[4] So, the healthcare system must shift its focus from infectious diseases to non-communicable diseases (NCDs).

Diseases are divided into acute and chronic due to different characteristics in the main causes, the duration of the symptoms and the rehabilitation process as well as the likelihood of being recurring or degenerative. In general, acute illness is said to be due to causes external to the patients' lifestyle and genetic heredity. So, acute disease is generally due to viruses, bacteria or route accidents, whereas chronic disease is said to be due to some sort of genetic proneness towards the manifestation of it, which may or may not be triggered by the patients' lifestyle. By that description, the chronic disease spectrum includes cardiovascular

diseases, cancer and diabetes. Of course, chronic diseases that are caused by viruses, such as HIVs and herpes zoster exist as well, but in this body of work we focus on the non-viral chronic diseases. Additionally, this body of work does not refer to people with permanent physical disabilities or addictions, despite the ongoing debate on the addressing of addiction as disease.

Chronic diseases are more prevalent now than they have been in the past years as a result of prolonged longevity and urban lifestyle risk factors. Another innate characteristic of chronic disease patients is that they bear a heavier financial cost both for themselves and the states. Modern policy makers try to configure new measures to minimize financial burden and ameliorate the lives of millions of chronic patients.

To evince the differences between acute and chronic diseases we can distinguish them by coding their characteristics as exposed in the following table: [5]

Characteristic	**Acute**	**Chronic**
Prevention	Vaccines and medications may help people avoid some acute conditions.	To prevent chronic conditions, people may need to change their behaviour, lifestyle, and dietary habits.
Onset	Acute conditions have a sudden onset, often with no warning signs.	Chronic conditions have a gradual onset and may have warning signs.
Symptoms	Acute conditions often have clear, specific symptoms.	Chronic conditions may have ambiguous symptoms that overlap with or are similar to those of other conditions.
Diagnosis	Healthcare professionals can usually give a specific diagnosis for an acute condition.	Chronic conditions often have ambiguous or unclear diagnoses or a spectrum of diagnoses.
Treatment	Healthcare professionals can usually treat acute conditions with an established cure. These conditions may also go away on their own.	Chronic conditions rarely have one cure, and medication may only manage symptoms of the condition or slow its progression.
Duration	Acute conditions have a short course or duration.	Chronic conditions often have a lengthy course and may be lifelong.
Care	Healthcare professionals usually actively treat a person for acute conditions.	With chronic conditions, a person is more active during their care, often in partnership with a caregiver or healthcare team. People may also need to make lifestyle changes to manage chronic conditions.

Recovery	People are more likely to make a full recovery from an acute condition.	People with chronic conditions may have long-term health effects and may live with the condition for their lifetime.
Outlook	People do not often have uncertainty about their future health with acute conditions. They are also less likely to relapse.	People with chronic conditions may feel uncertain about their health as they age. They may experience periods of relapse or flare-ups of the same chronic condition.

After that sort of distinguishment, one may realize that the range of pathogenic conditions referred to as chronic diseases are not limited to certain medical specialties. On the contrary, most of the time they require holistic approach, as even multimorbidity is often present. To cite a few of the most prevalent categories of chronic disease, these would be diabetes, cardiovascular diseases, cancers and chronic respiratory diseases.

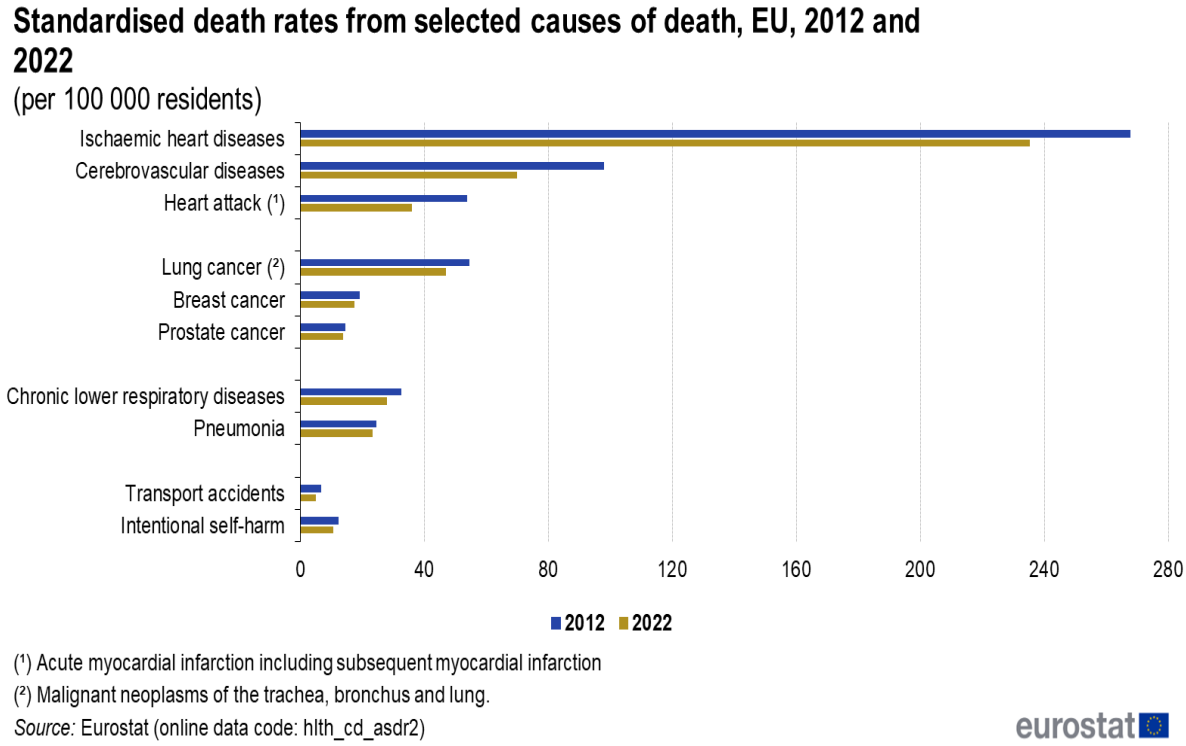
According to World Health Organisation, who groups chronic diseases under the name of non-communicable diseases, chronic diseases were the cause of death in 38% of all deaths worldwide in 2021.[6] But except for the mortality rate, according to OECD data collection, the rate of people suffering from a chronic health condition is a striking one third of the world's population.[7] The latest statement is reinforced by reports that imply still or falling mortality rates by chronic diseases, with still incidences, which implies a larger part of the population surviving the chronic disease and tackling its effects in working and pensioner life. The US Centre for Disease Control and Prevention bluntly states that chronic disease is the leading cause of illness and death in the USA, while 4 in 10 Americans report multimorbidity.[8] The European Cancer Information System, which lies accountable to the European Commission, predicts that by the age of 75 one fourth of the female population and 31% of the male population of the EU citizens will be diagnosed with cancer.[9]

Europeans seem particularly affected by cancer as 25% of worldwide cancers reported annually refer to EU countries.[10] Multiple sclerosis seems also particularly affecting Europe, as more than half of the people diagnosed with MS reside in European soil.[11]Another steadily increasing chronic disease that affects all countries but shows higher rates in high income countries and is related with old age, is dementia. Dementia is deemed to rise as an outcome of ageing populations. Of course, in absolute numbers, the most of patients reside outside the high-income countries, as over 60% of dementia patients reside in low- and middle-income countries.[12]

As someone may notice, chronic diseases are not studied altogether by the same institutions, neither do all public health units and medical organisations in all countries record and report chronic disease data in a coherent and universally uniform manner. So, except for the OECD and WHO datasets, information about chronic disease is scattered through different national or international institutions where some only study cancers, others only cardiovascular diseases etc. The result of this fragmentation is having respectively fragmented information over the evolving trends in chronic diseases mortality, incidence and prevalence as well as to the effects of the latest treatment methods. Nevertheless, even in that state of documentation, some geographic tendencies can be detected, such as the

higher death rates due to chronic disease at the low and middle-income countries of the South in comparison to the West, or the higher death rates in Eastern EU countries in comparison to Western and Northern. Even within each country of the Member States, chronic diseases seem to affect disproportionally people from lowest income ranks.

Following diagrams and maps which visualise some of the facts described above:



Source: Eurostat's statistical themes of 'Causes of death statistics' as of March 2024

Bar chart depicting the rate of deaths caused by specific factor per 100,000 residents in the EU. Blue bar refers to the rate of 2012 and brown bar to the rate of 2022. All cause-specific deaths have decreased during the studied decade, even though not at equal rate. The ranking of death rate by specific cause ordering is left the same, with ischaemic heart disease, cerebrovascular diseases, heart attack, lung cancer and chronic respiratory diseases taking the most significant toll on the European population, followed by breast and prostate cancer. Intentional self-harm and transport accidents are also listed, though at the lowest ranks.

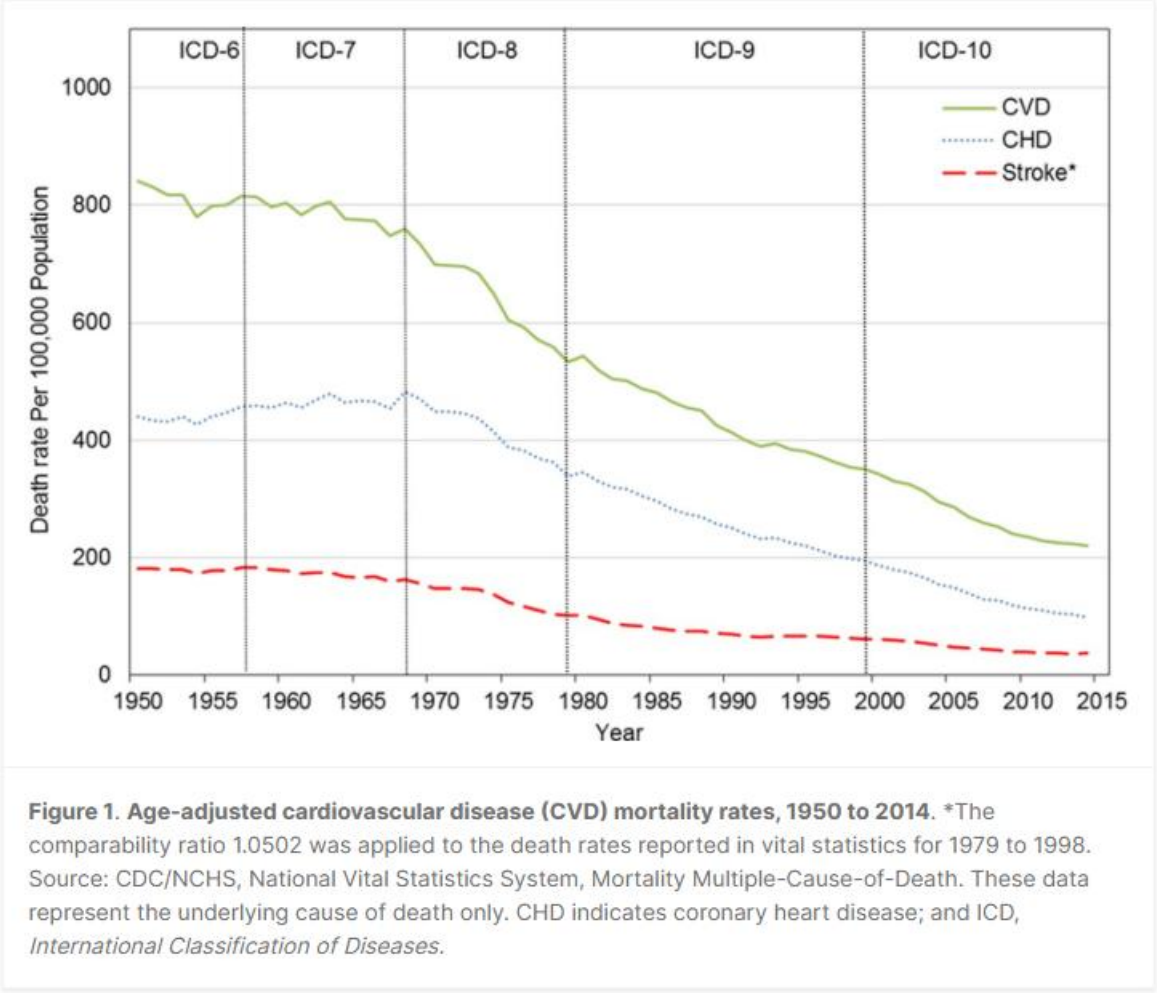
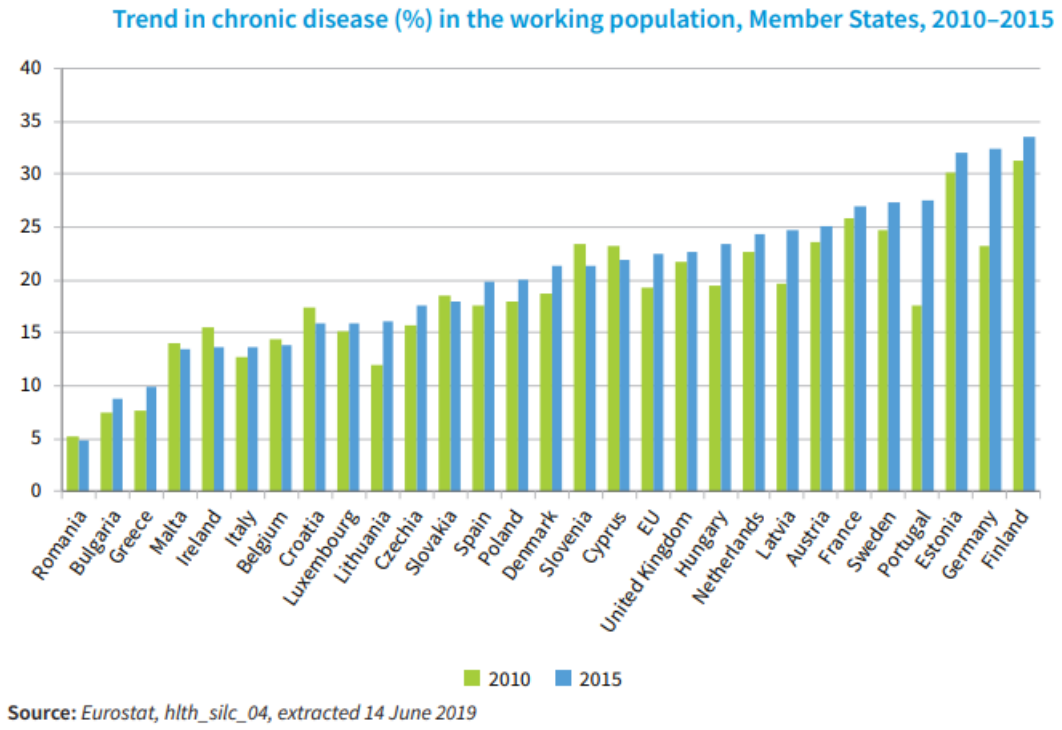


Figure 1. Age-adjusted cardiovascular disease (CVD) mortality rates, 1950 to 2014. *The comparability ratio 1.0502 was applied to the death rates reported in vital statistics for 1979 to 1998. Source: CDC/NCHS, National Vital Statistics System, Mortality Multiple-Cause-of-Death. These data represent the underlying cause of death only. CHD indicates coronary heart disease; and ICD, *International Classification of Diseases.*

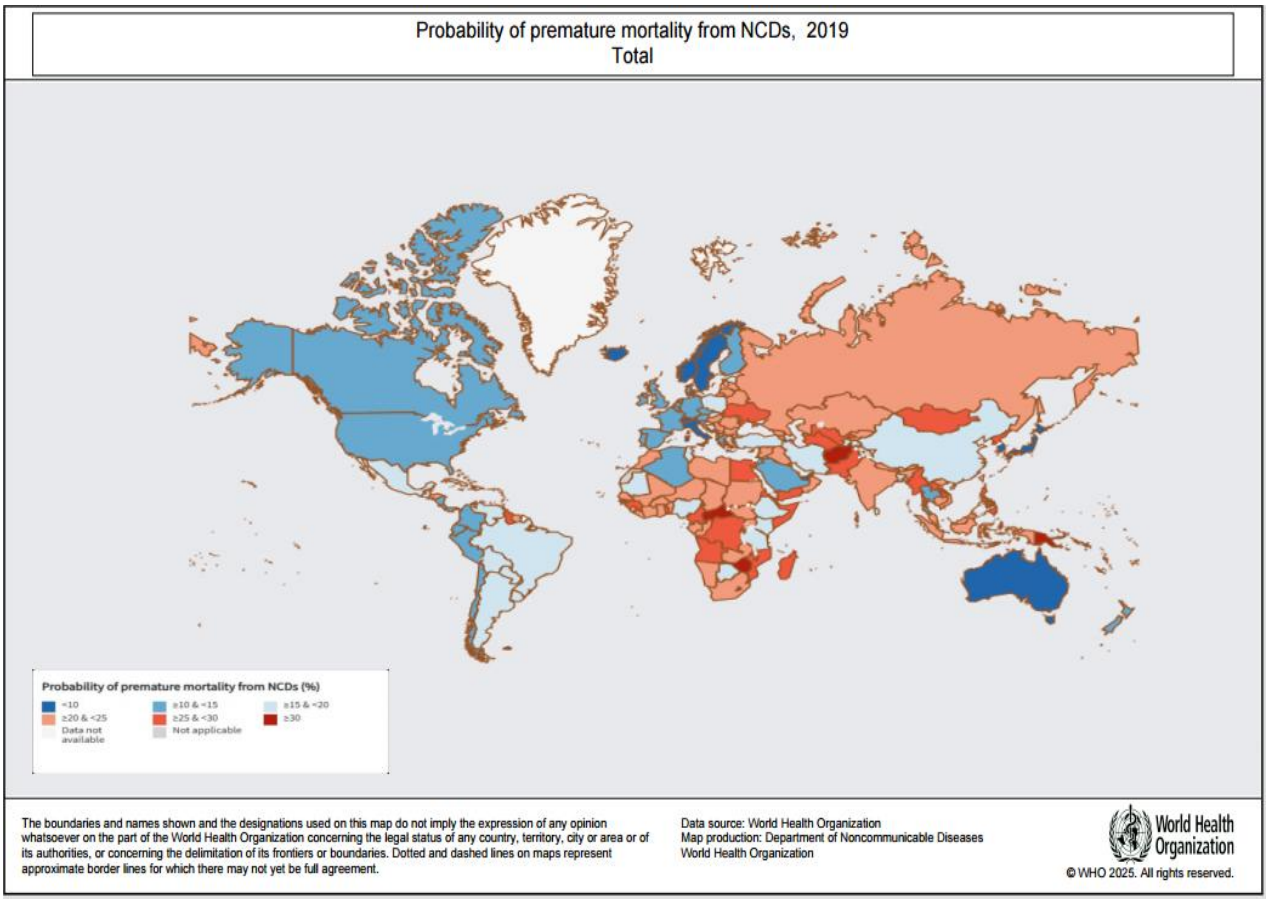
Source: review article "Decline in Cardiovascular Mortality: Possible Causes and Implications" as published in American Heart Association journal, January of 2017

Chart that depicts the decreasing trend of cause-specific deaths per 100,000 residents in the United States of America from 1950 to 2015. Green line refers to cardiovascular disease (CVD) caused mortality rate, dotted blue line refers to coronary heart disease (CHD) and dashed red line refers to stroke. All cause-specific deaths have been diminished by half, but ranking remains the same with CVD ranked most important cause of death, CHD second and stroke third.



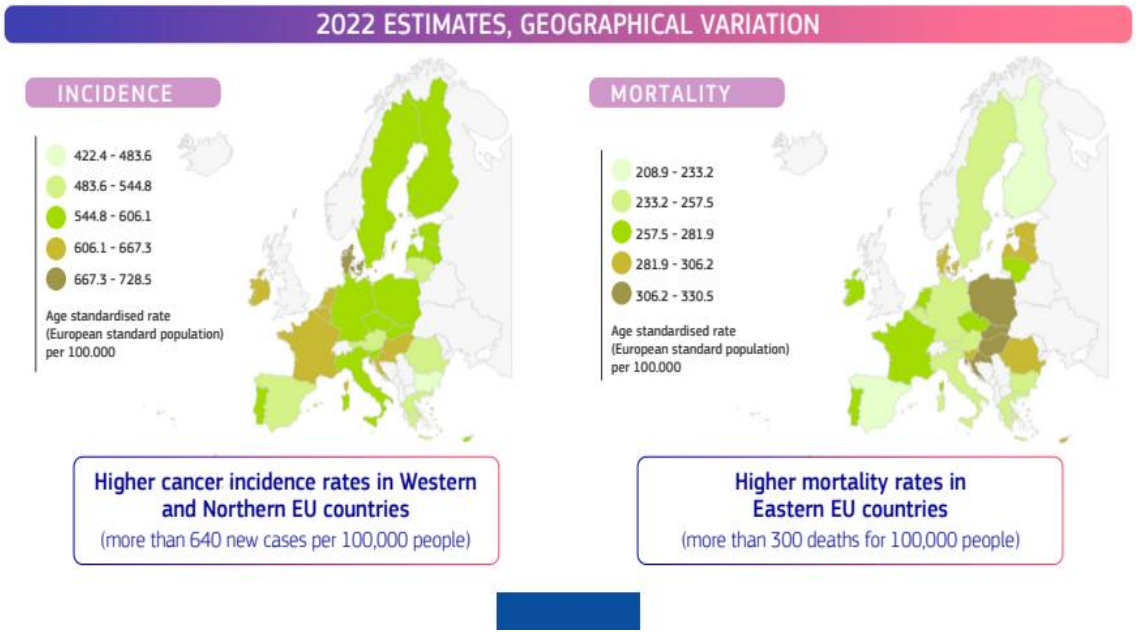
Source: Policy brief publication of Eurofound titled 'How to respond to chronic health problems in the workplace?', 2019

Column chart that depicts the recorded trend of working population with chronic disease in the quinquennium 2010-2015 in EU Member States. Green column depicts data from 2010 and blue column from 2015. The EU average has increased the rate of the working population with chronic disease in the studied interval, while 5 Member States have a rate that exceeds 15% of the working population but remains lower that 20%, and 16 Member States have rate equal or more to 20% of the working population.



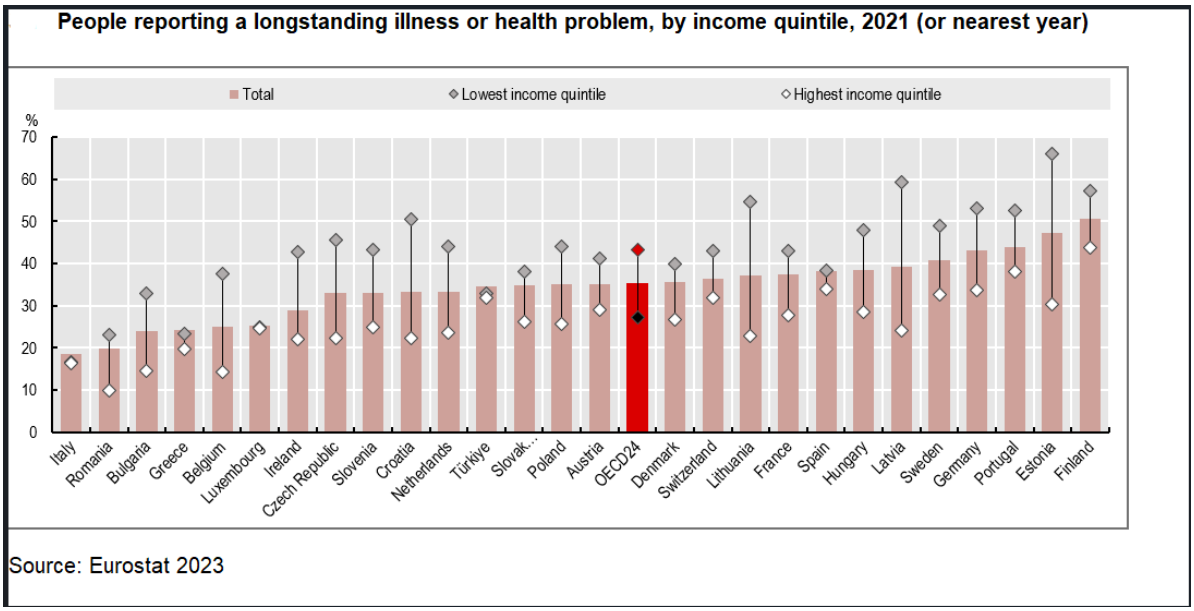
Source: Noncommunicable Diseases Data Portal by World Health Organization

Colored map that depicts countries as divided by national boundaries, colored on a scale of blue and red hues according to the level of the probability of its residents to die prematurely due to a noncommunicable disease, based on data as of 2019. The bluer the hue the less probable for these residents to die prematurely from a noncommunicable disease and the redder the hue the most probable for the residents to die from a noncommunicable disease. Residents in Australia, most of the Americas and Northern and Central Europe are less likely to die prematurely, while in most of Africa and Asia -especially Central- and Eastern Europe people have substantially increased levels of premature death due to a noncommunicable disease -25% and over chance. Greece lies on the blue side with 12% chance of premature death.



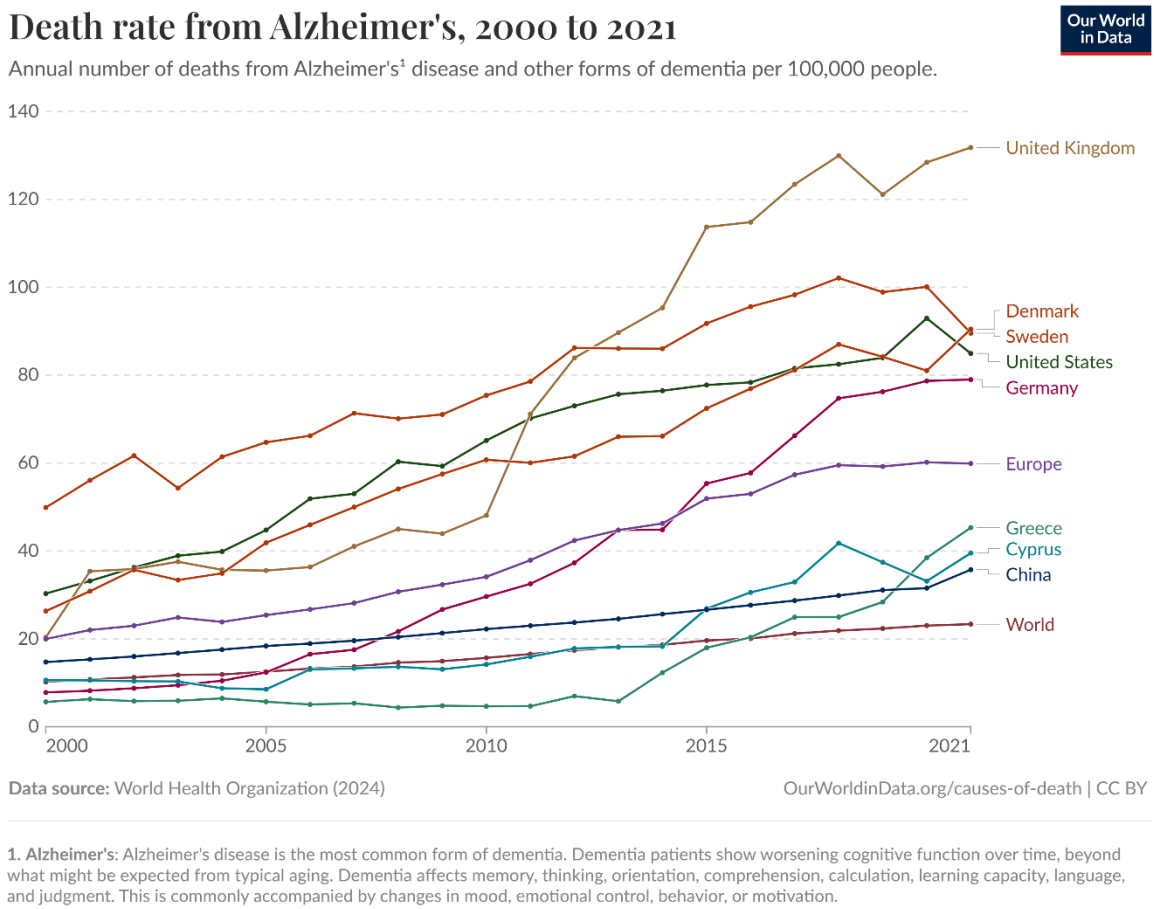
Source: European Cancer Information System's 2022 factsheet

Two coloured maps depicting incidence rates per 100,000 people (left) and mortality rates per 100,000 (right) in the EU Member States with data from 2022. The darker the hue the higher the rate. It is indicated that while Western and Northern EU countries have more common incidence of cancer (more than 640 new cases per 100,00 people) it is the Eastern EU countries who carry the higher mortality rates (more than 300 deaths for 100,000 people). That striking contradiction probably implies that in the Western and Northern EU countries early detection is promoted more effectively and by following special treatment in earlier stages of cancer, premature death is more likely to be avoided. Greece is ranked in the lower rate of both incidence and mortality, that is 484 to 549 cases of cancer incidence per 100,000 residents and 233 to 258 cases of cancer-caused death per 100,000 residents.



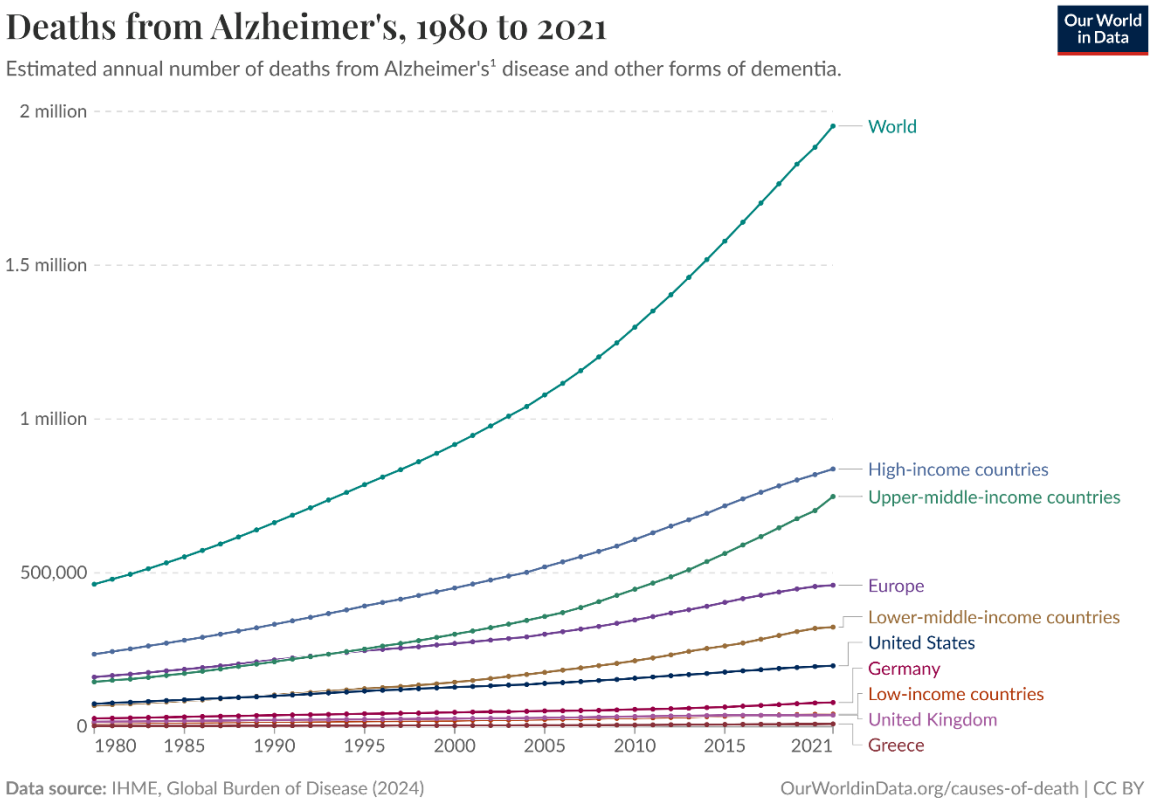
Source: OECD's publication 'Health at a Glance: OECD Indicators 2023', November 2023

Columns and dots chart depicting three indicators concerning several member states of OECD with data from 2021: a) the rate of a country's population who reports a longstanding illness or health problem is depicted by the vertical red bars, b) the proportion of the lowest income quintile patients to the total of chronic disease patients in each country is depicted by the grey dots, and c) the proportion of the highest income quintile patients to the total of chronic patients in each country is depicted by white dots. It is presented as the OECD's average of people reporting a longstanding illness is on 35% of the population, which slightly increases in countries with typically higher gross domestic product but only exceeds 40% in five countries. When income status of chronic patients is examined, we see that the lowest income quintile makes up more than 40% of the reported chronic illnesses while the highest income quintile makes up around 25%. The trend of lowest income making up the most of chronic illnesses patients in comparison to the highest income is true for all studied countries, even if the range of that positive difference varies. As far as Greece is concerned, only a rate of a few more than 20% report a longstanding condition, with highest income quintile making up the 20% of the reported cases while the lowest income quintile makes up a little more than 20%, grouping Greece among Turkey and Spain in the group of countries where the difference of the lowest-highest quintile is less than 5%.



Source: Visualization of data from World Health's Organization publication of 2024 by Our World in Data team under the topic of 'Causes of Death'

Line graph that depicts the trend of Alzheimer-caused deaths over 21 years, from 2000 to 2021. The rate refers to deaths per 100,000 people and each colored line represents another country except for one brown line that represents the global rate and a purple one that represents the whole of Europe. We observe that old time established powerful economies show a sharper rise in Alzheimer-related deaths in comparison to newly powerful economies- the slope of China's increase is substantially lower than the one of USA and UK. That might be due to well established higher life expectancies in the Western countries. Nevertheless, regardless of the degree of increase and the fluctuations of the mortality rate per se for each country, a positive trend is indicated for all specific countries and for the world as a whole. The rate for Greece shows a sharp increase from mid-2010's to 2021 from concerning a few more than 1 per 100,000 to more than 40 per 100,000 people, but this might be due to changing the administrative reporting of these instances, which were previously undercovered by other causes of death.



Source: Visualization of data from Institute of Health Metrics and Evaluation (IHME) publication of 2024 by Our World in Data team under the topic of 'Causes of Death'

Line graph that depicts the trend of dementia-caused deaths over four decades, from 1980 to 2021. The trend is attributed to absolute numbers of dementia-caused deaths, and each colored line represents conventional agglomerations of countries based on indexes defined by the Institute of Heath Metrics and Evaluation, and a few separate countries. The graph confirms the rising trend of dementia-caused deaths with numbers growing threefold in the studied decades. The trend is still primarily pushed up by higher income countries, even though upper-middle income countries are experiencing a sharper rise since 2000, and lower-middle income countries follow a similar slope to the European whole.

Risk factors for chronic disease

The reported rise in incidence and prevalence of chronic disease is accompanied by the rise of other noted attributes in modern lifestyle, which are deemed as closely linked to the chronic diseases. Some as causes of chronic disease (e.g. smoking) and others as results of it (e.g. unemployment).

i. Behavioral risk factors for chronic disease

According to WHO's Global Health Observatory, most chronic diseases are linked to four key metabolic changes (high blood tension/hypertension, high blood sugar, obesity and high cholesterol) which all four are linked to modern lifestyle behavior which includes heavy

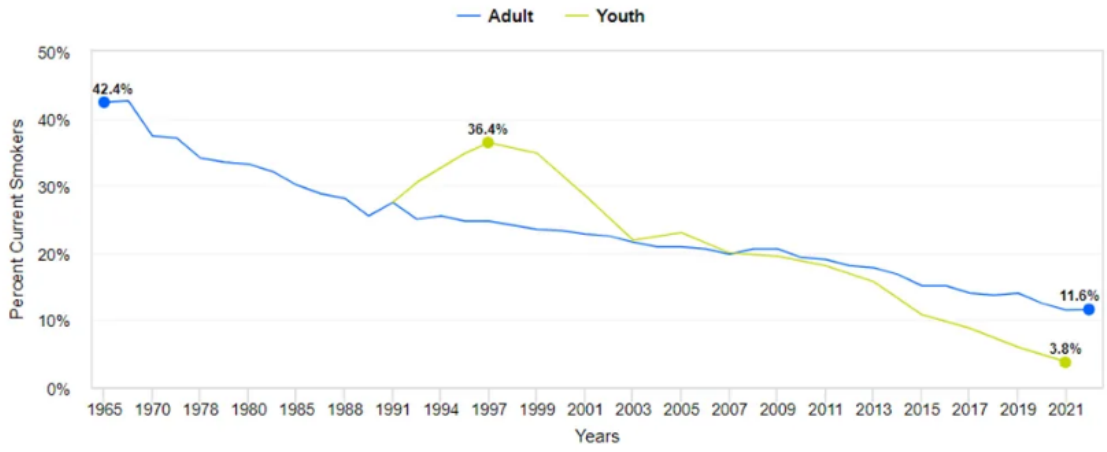
tobacco use, unhealthy diet rich in sugar, fats and salt, physical inactivity and harmful alcohol consumption.[13]

Global trends show a moderate reduction in alcohol consumption and tobacco smoking because of central health promoting policies, better health literacy, bans on advertising and taxes on sale of cigarettes and alcoholic beverages in the latest decades. Nonetheless, millions of people are still clinging to these behaviors. Available data for Greece indicate that Greeks have cut tobacco consumption by almost two thirds in 2021 in comparison to 2009,[14] but Greeks in 2019 are still ranked second after Bulgarians in the EU for having the second higher percentage on smokers in the general population with Greece reaching more than 20%.[15] Nonetheless, the use of tobacco smoke by Greeks has decreased by half since the 2000's.[16] Alcohol consumption in Greece is loosely recorded, but certain indexes such as prevalence of heavy episodic drinking at least once a month, rank Greece towards the smallest rates within EU member states,[17] and by that we could assume that alcohol consumption is not as prevalent in Greece.

Obesity's trend is a more concerning risk factor as it affects increasingly more people regardless of policies that promote physical activity and healthy balanced diets. It is estimated that the obesity rate has tripled since 1975. Once a problem of the higher income countries, now it affects equally the rest of the world. In 2019 alone, obesity was the cause of non-communicable diseases who resulted in death for 5 million people.[18] In Greece specifically 54.9% of the population is overweight or obese, according to the Greek Statistical Authority.[19]

Physical inactivity was not recorded in the past, so not much data over time is available. It affects, though, roughly one third of adults and a striking 80% of adolescents worldwide at present tense.[20] Greece scores among the European countries with higher levels of physical inactivity.[21]

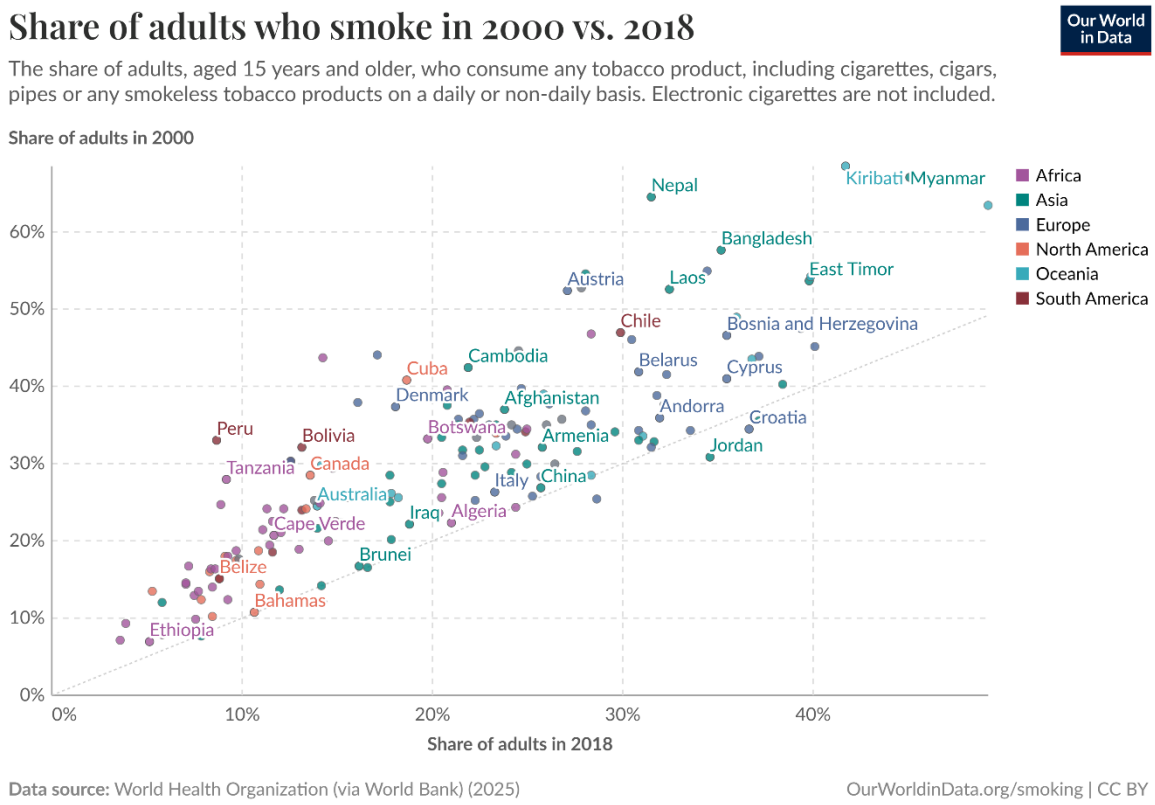
Following diagrams and maps which visualise some of the facts described above:



Cigarette Smoking in the U.S. by Age Group, 1965–2021. Source: American Lung Association

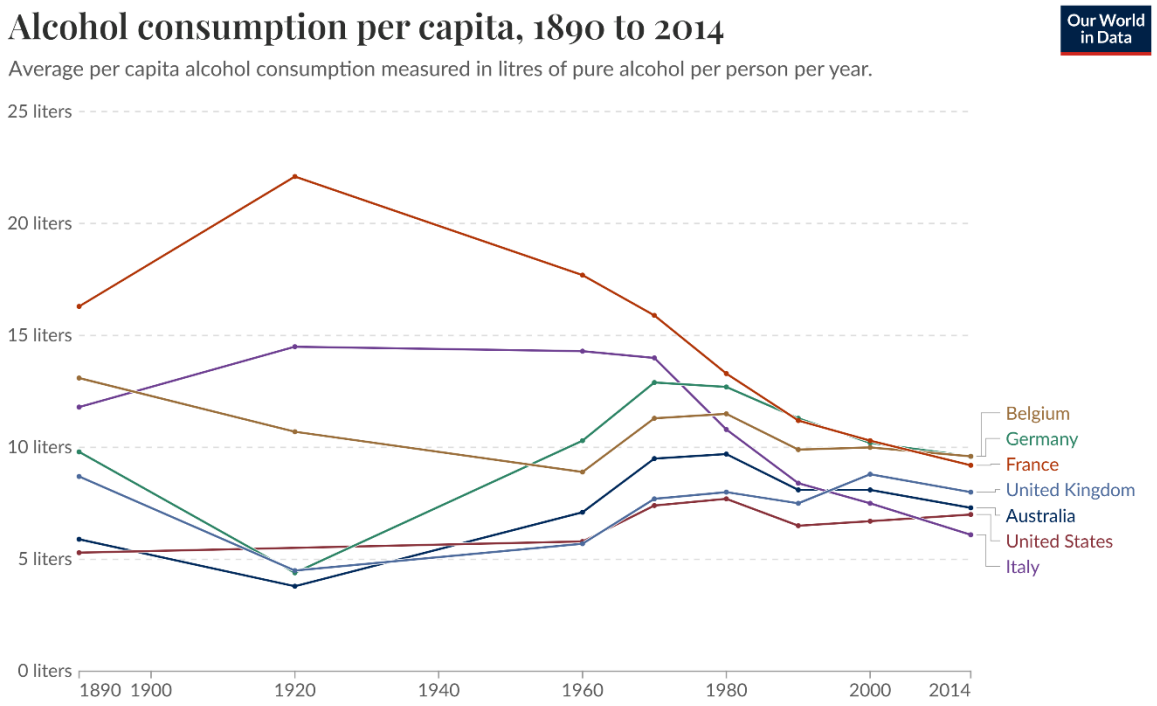
Source: Medium magazine article 'Tobacco Use Trends: A Substantial Change Over Time', November 2024

Line graph depicting tobacco (cigarette) smoking percentage of the population in the USA throughout the years 1965 to 2021. Blue line refers to adults who smoke and lime line to adolescents. Smoking adults peaked in 1965 when smoking was habitual for 42.4% of adult population and has an ever-decreasing slope from then with the percentage of tobacco smokers in 2021 making up 11.6% of the adult population. Tobacco smoking among adolescents peaked in 1997 with a 36.4% of the teenage population smoking and declined ever since with the percentage reaching 3.8% in 2021.



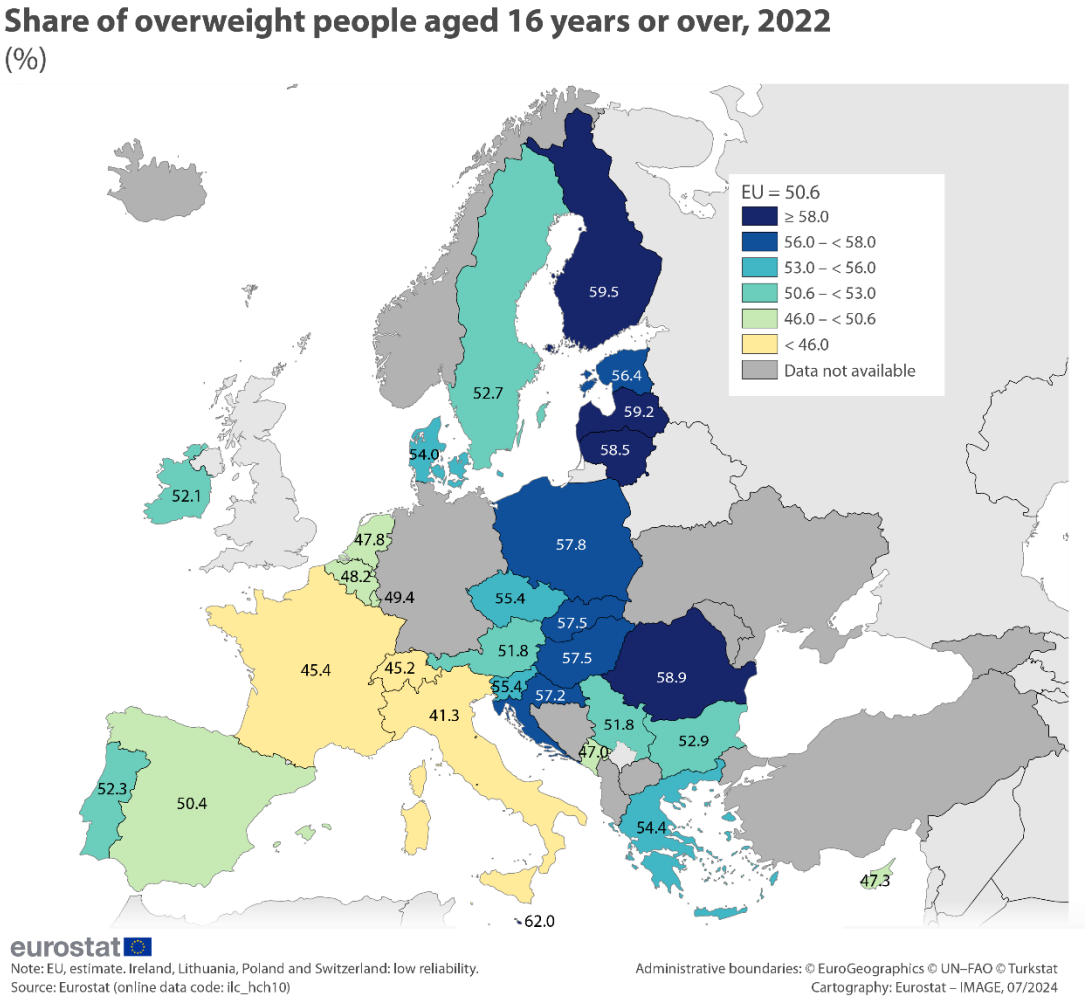
Source: Visualization of data from World Health Organization (via World Bank) publication of 2025 by Our World in Data team under the topic of 'Smoking'

Dot chart that compares the percentage of smokers in the general population of several countries in the year 2000 to the year 2018. Each country is represented by a colored dot. Vertical (x) axis represents the percentage of the population that smoked regularly in 2000 and horizontal (y) axis the same percentage in 2018. The closer a dot is located to the diagonal axis, the less of a difference on the smoking percentage of the population. The absolute majority of countries showcase a reduction in smokers' percentage, as most countries reside between the vertical axis and the diagonal axis. Of course, not all countries share similar rates of smoking population or degree of reduction in that percentage. For example, in Nepal, in the year 2000 more than 6 out of ten people smoked tobacco, but in 2018 that percentage lowered to a little more than 3 out of 10. In Italy on the other hand, the percentage is seemingly still a little above 20% in both cases. No correlation can be implied by the size of the economy of one country and its smoking habits from this chart.



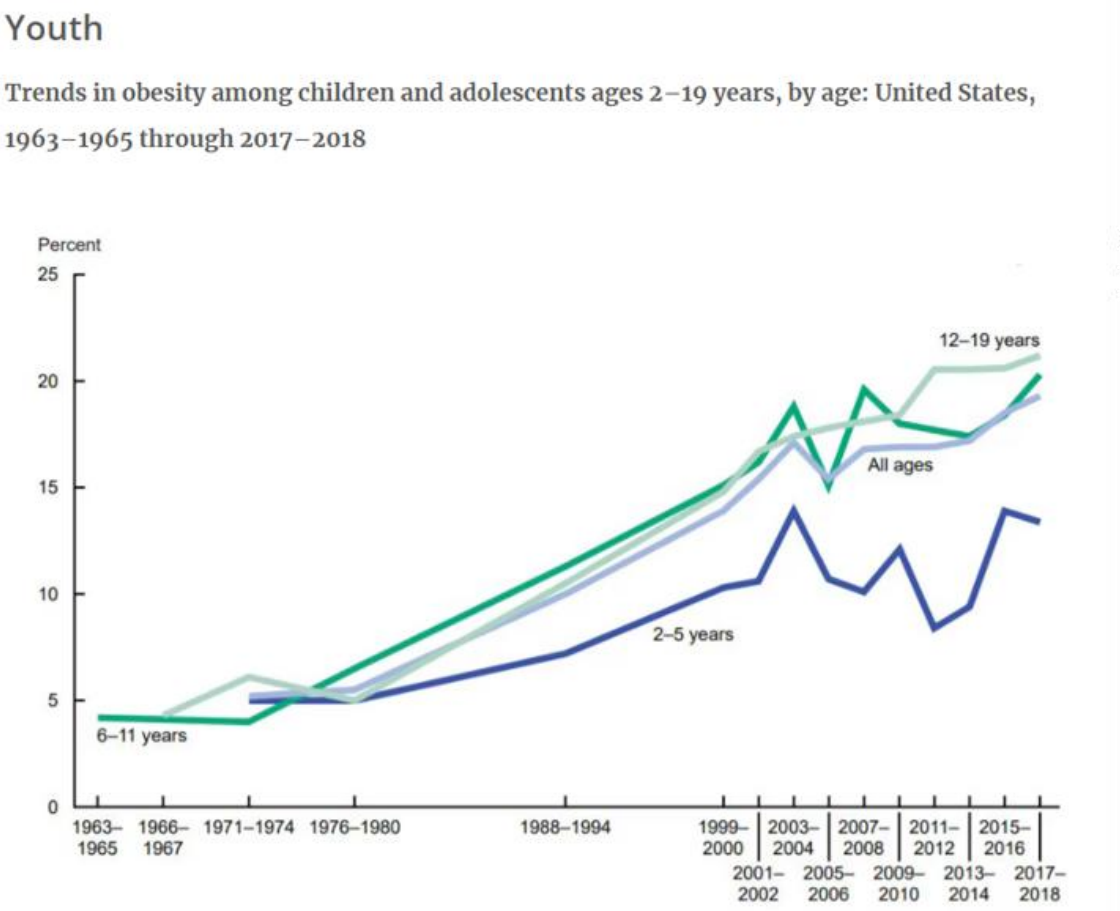
Source: Visualization of data from research named 'Convergence in national alcohol consumption patterns: New global indicators' conducted by Holmes & Anderson in 2017, by Our World in Data team under the topic of 'Alcohol Consumption'

Line chart that depicts the changes in average alcohol consumption per capita from 1890 to 2014. Vertical axis depicts absolute liters, and horizontal axis depicts the studied years. Each colored line refers to a Western country. For the whole of the twentieth century we observe uneven fluctuations between countries, but for the most countries there is a rise in consumption between 1960's and 1980's, and after that a steady but mild reduction for all except for United Kingdom which is the only country facing larger consumption levels in 2014 than 1980, even though for only a couple of liters.



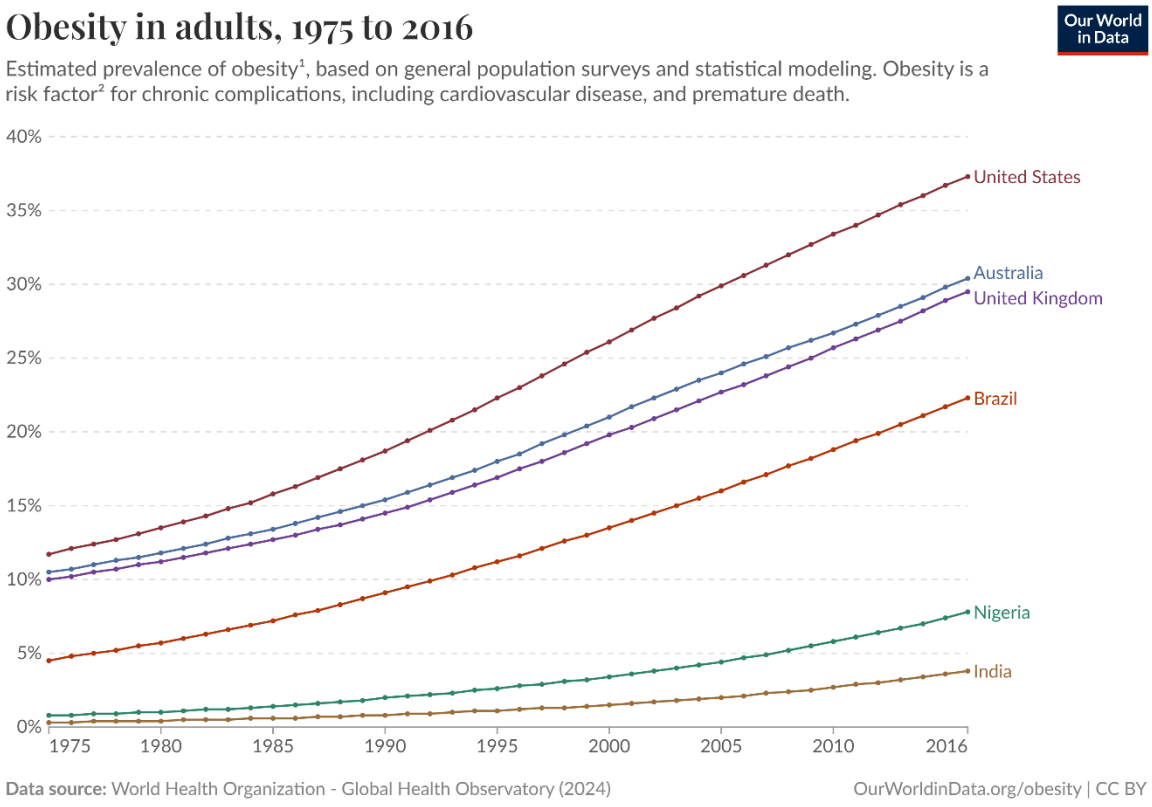
Source: Eurostat's statistical themes of 'Overweight and obesity – BMI statistics' as of July 2024

Political map of Europe with colored countries according to a coloring scale for the percentage of residents of 16 years of age and above who are overweight. The lighter the shade in one country, the less overweight people it hosts as a percentage to its general population. The greatest share in overweight population is presented in Northern and Eastern Europe with Greece lying on an average of 54.4% of residents (grossly one in two Greeks) being overweight. Notably, the relative difference of the overweight people percentage from the country with the biggest share, that is Finland with 59.5% of the population being overweight, is only 18% different from Italy who bears the smallest share on 41.3% of the population being overweight. Having a minimum 40% of the population being overweight is already a worrying index.



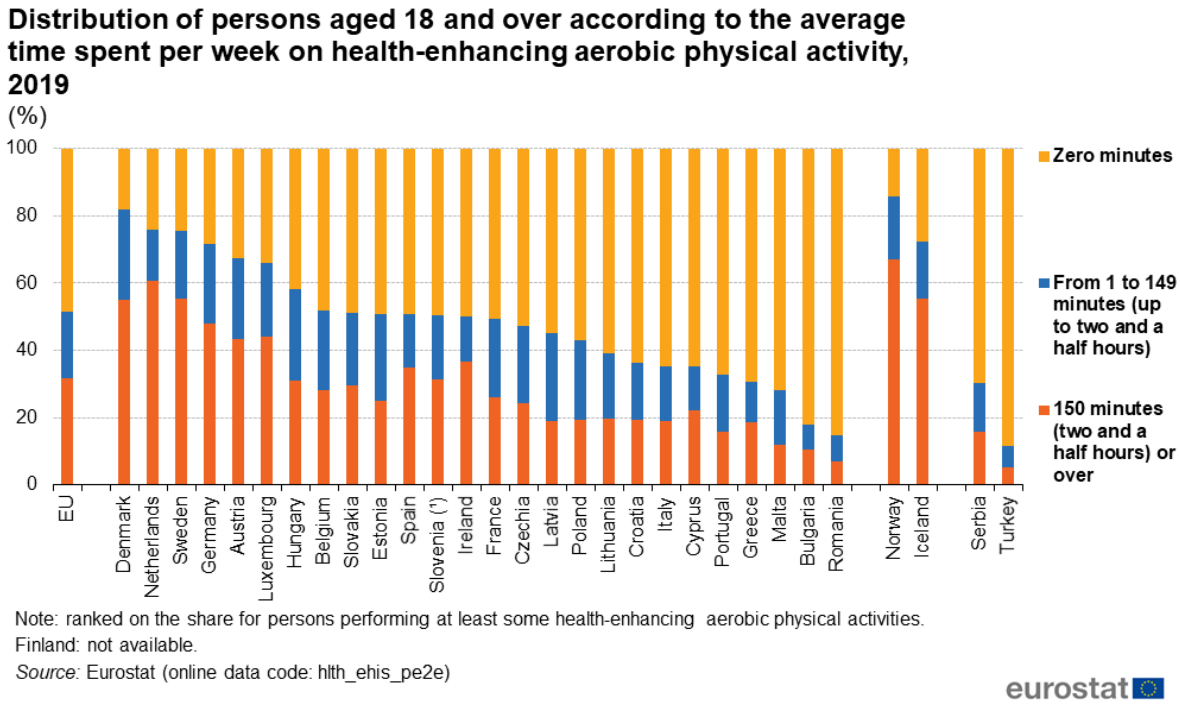
Sources: National Center for Health Statistics, National Health Examination Surveys II (ages 6–11) and III (ages 12–17); and National Health and Nutrition Examination Surveys (NHANES) I–III, and NHANES 1999–2000, 2001–2002, 2003–2004, 2005–2006, 2007–2008, 2009–2010, 2011–2012, 2013–2014, 2015–2016, and 2017–2018

Line chart that visualizes the trend of obesity among children and adolescents in the United States throughout the years from 1963 to 2018. Vertical axis represents the percentage of obesity in the general underage population and horizontal axis represents time. Each colored line represents a different age group from 2 to 19 years of age. All age groups show a sharp rise in obesity percentages from 1970 to having quadrupled in 2004 and continuing to rise until 2018 at a slower pace.



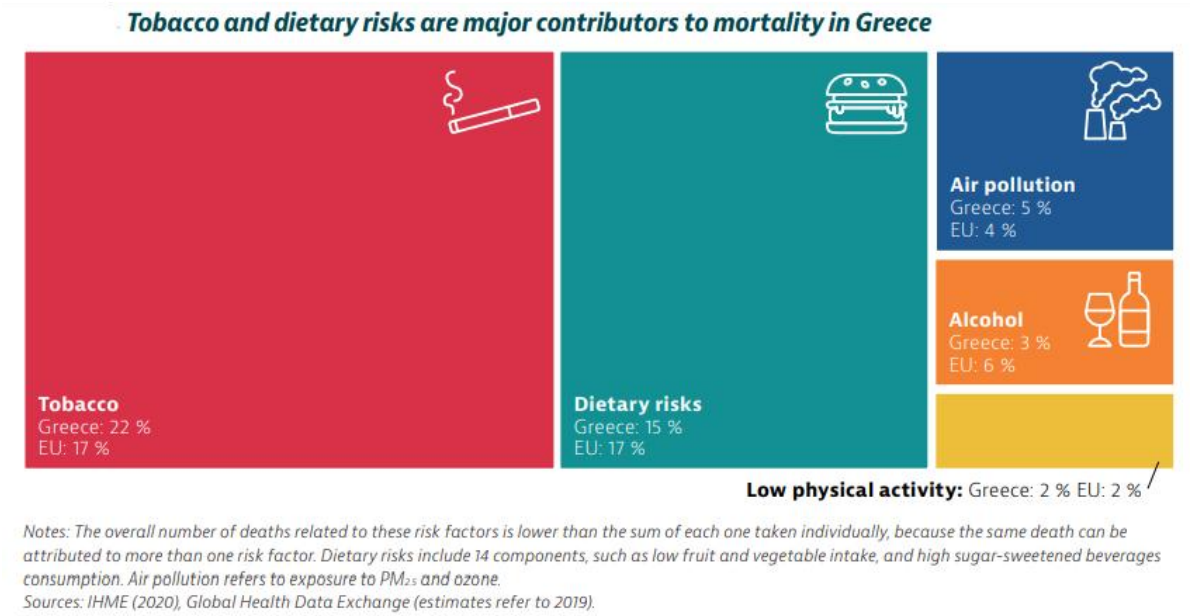
Source: Visualization of data from World Health Organization – Global Health Observatory's data of 2024 by Our World in Data team under the topic of 'Obesity'

Line chart that depicts the rise of obesity as share of the general population in six indicative countries from 1975 to 2016. All countries under scope show a rising trend with western economies being more heavily affected as they tripled or even quadrupled (USA) their share of obese population in the studied decades. Especially UK, Australia and USA characterize as obese the staggering 30% of their population by 2016. Notably, obesity rates do not include the overweight rate of the population. That is the overall rate of overweight and obese people in these countries is expected to be significantly higher than 30%. Nigeria and India are also showcasing a rise in their obesity rates, having fivefold rise from around 0% to 5% but the rate remains considerably lower than in old established economies.



Source: Eurostat's article "Health-enhancing physical activity statistics", May 2022

Stacked bars/columns chart that depicts the stance of residents of EU Member States plus a few more countries on aerobic physical activity with data as of 2019. Each column represents the whole of the country's population, and the divided colored parts constitute the percentage of the population that fitted in one of the three categories in question: yellow part represents the percentage of people who spent zero minutes on health enhancing aerobic activity, blue part the percentage of people who spent from 1 to 149 minutes weekly and the orange part the percentage of people who spent 150 minutes or more. We extract the conclusion from the graph that people in Northern of Europe have a healthier stance towards physical activity as in most cases some time of aerobic activity is concerning at least 50% of the total of the population. As we move towards the Mediterranean Sea, the participation in physical activity diminishes. Greece stands in the fourth place of the least aerobic active people after Romania, Bulgaria and Malta. In Greece roughly 30% of the population engaged in any aerobic activity weekly in 2019.



Source: European Commission's State of Health in the EU Greece Country Health Profile 2023

Treemap chart that demonstrates the contribution of several health risk factors on causes of mortality in Greece with data as of 2020. By the size and tag of each nested rectangle we conclude that tobacco use takes the highest toll on Greeks, being higher than the EU average (22% in Greece whereas 17% in EU average), second come the dietary risks, where Greeks have a slightly lighter burden than the EU average (15% in Greece and 17% in EU average), third comes the air pollution, which bears a heavier burden in Greece than the EU average (5% in Greece and 4% in EU average), fourth comes alcohol consumption, where Greece has half the burden of EU average (3% in Greece while it is 6% for the EU average) and last comes low physical activity with Greece lying on the EU average on 2%.

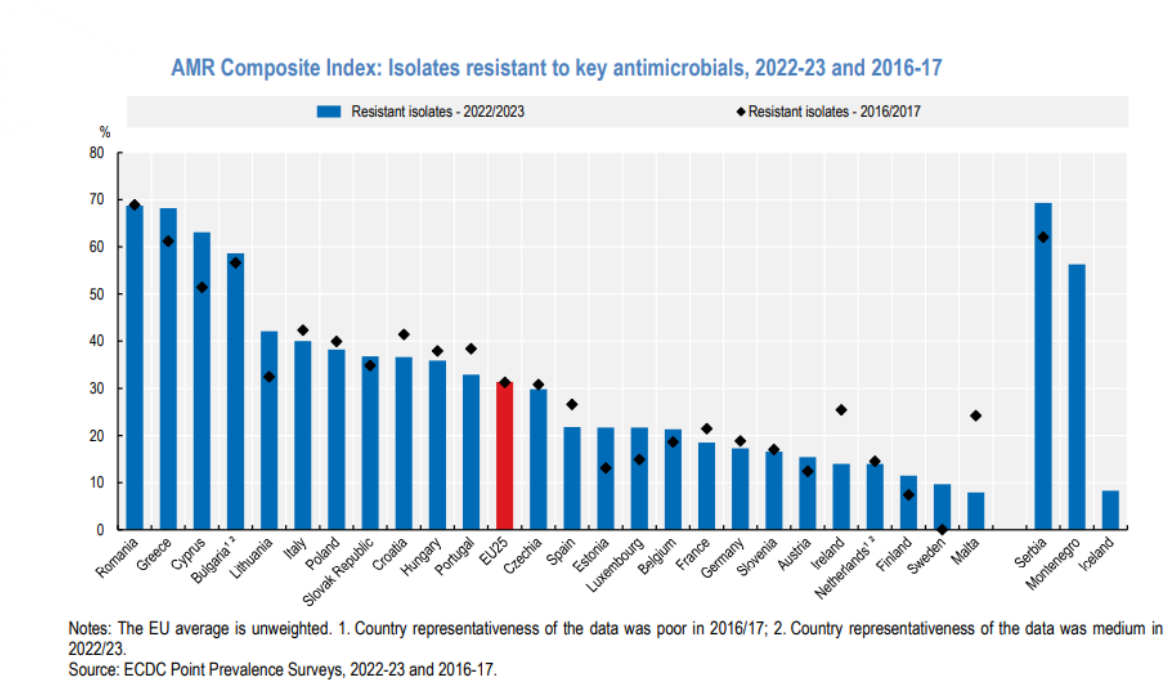
- **Drug abuse**

A special attribute associated with chronic disease is drug abuse. Both legal and illicit drugs are associated with chronic disease, both as a cause and as an outcome. Illicit drugs are associated with cancerogenic effects[22] while overconsumption and addiction to drugs of any source is linked to people suffering symptoms of chronic disease.[23] The phenomenon of abusing substances meant for palliative care is described as comorbidity of chronic disease and substance use disorders.[24] Both cases of drug consumption are associated with social alienation.

At the moment, the use of illicit drugs is indicatively on the rise as confiscations reveal that larger amounts of drugs are transported from producer countries to consumer countries (UK, USA and EU).[25] We may deduce from this fact that recreational thus cancerogenic consumption is expected to rise and palliative use will be more accessible leading to more addicted chronic disease patients.

On the other hand, abuse in over the counter and prescribed medical drugs is rather understudied, as many experts refer to the phenomenon, but very few data are collected and reported in the public eye. Nonetheless, studies conducted for the EU indicate an unbeatable trend of antimicrobial resistance (AMR) which is an indicator of misuse of antibiotics from

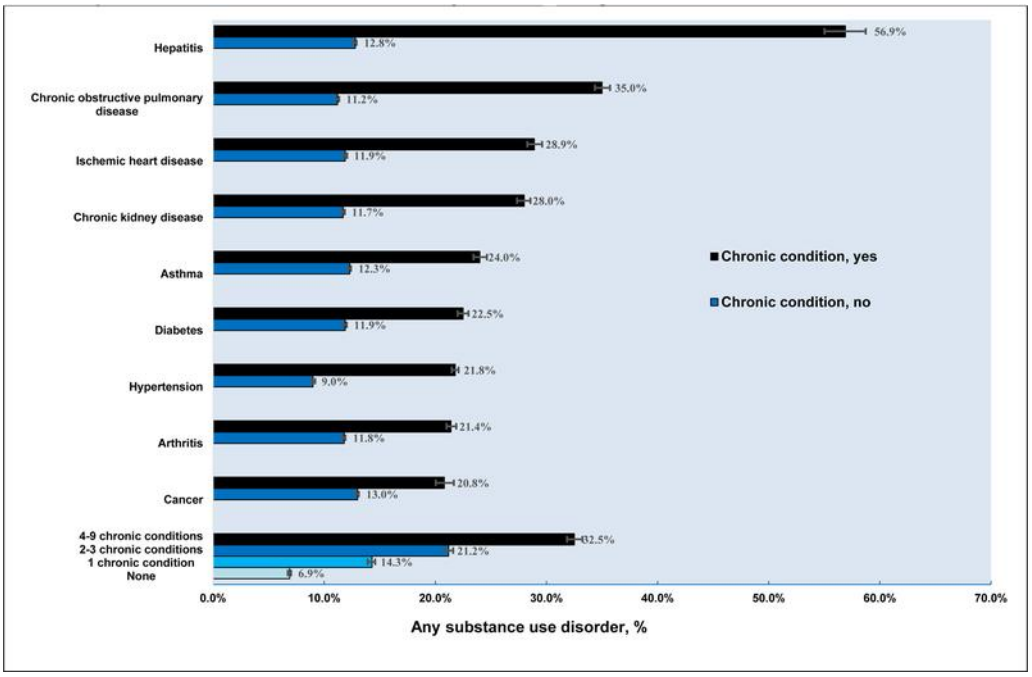
the general population.[26] AMR might not cause a chronic disease, albeit chronic disease patients are mostly vulnerable group to bacterial infection.



Notes: The EU average is unweighted. 1. Country representativeness of the data was poor in 2016/17; 2. Country representativeness of the data was medium in 2022/23.
Source: ECDC Point Prevalence Surveys, 2022-23 and 2016-17.

Source: OECD's publication 'Health at a Glance: Europe 2024', November 2024

Chart that combines columns and dot plots to compare the level of antimicrobial resistance of reported bacterial isolates in each country in 2016-2017 and 2022-2023. Columns indicate the percentage of reported bacterial isolates resistant to first level AMR markers from the whole of the reported isolates in each country for the period 2022-2023 and black dots represent the same index for 2016-2017 period. Levels between the studied periods are lightly increased or decreased for each country in an even pattern so as the EU average has remained stable on 30%. Northwestern countries demonstrate a better image on AMR resistance while southeastern experience higher AMR resistance. For Greece and Cyprus specifically, the AMR resistance rose for 5% in Greece and 10% in Cyprus during the studied interval. Greece beholds the second place after Romania in AMR resistance period as in both time periods under observation, AMR resistance exceeded 60%.



Source: Drug and Alcohol Dependance Journal, November 2018
Article: Multicomorbidity of chronic diseases and substance use disorders and their association with hospitalization: Results from electronic health records data

Bar chart that depicts the percentage of patients admitted at least twice in Duke University Hospital in North Carolina from 2007 to 2014 by the status of their substance abuse. More specifically, vertical axis has listed nine chronic conditions. Black bars refer to patients having the specific condition and their likelihood of having any substance use disorder, while blue bars refer to patients without the specific chronic illness and their respective chance of having any substance use disorder. Towards the zero point of the chart the value of no chronic illness is listed among the cases of having one chronic condition, two or three chronic conditions and four to nine chronic conditions all represented by differently colored bars in comparison to the rest of the cases. Horizontal axis represents the percentage of substance abuse among patients. We observe that for all nine chronic conditions, the chance of a patient to have a substance disorder was significantly higher than one patient not suffering the specific chronic condition. Additionally, the prevalence of any substance use disorder increases proportionally to the number of the identified chronic conditions.

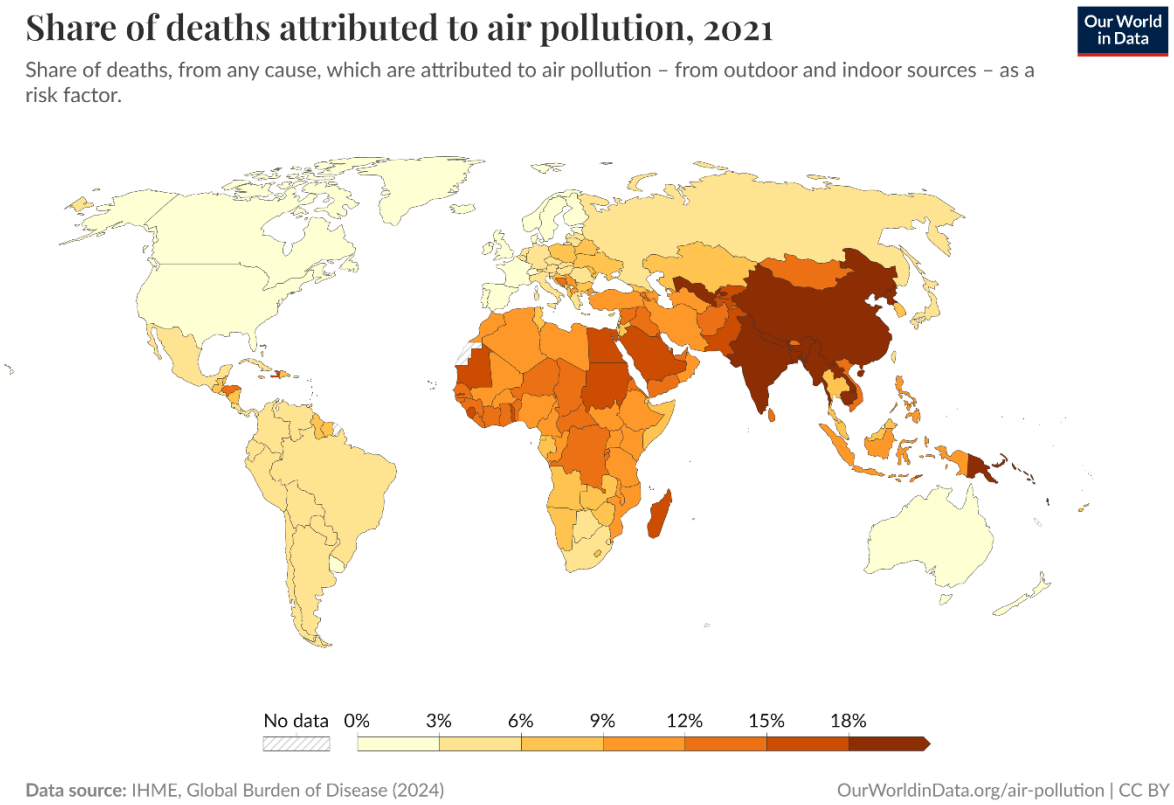
ii. Environmental risk factors for chronic disease

And while the aforementioned factors lie largely in the individual choice of the citizen, other factors do not. Environmental factors are usually beyond the discretionary choice of the individual who is subject to them. Polluted air, overexposure to industrial chemicals, disturbed sleep and rest, and overwork. All these factors may cause chronic stress and inflammation, which are directly linked to the metabolic changes that in turn cause chronic disease.[27]

Air pollution- both indoors and outdoors- is listed along the top causes of death worldwide. Even if global emissions of sulfur dioxide peaked in 1990 and decrease ever since, the rest of key chemical air pollutants- such as ammonia, nitrogen oxides, primary pollutants emitted from fuel chemical reactions in vehicles and industrial plants continue to affect millions of people.[28] Another key air pollutant is the particulate matter PM_2, also known as dust. Air floating dust can be omitted by traffic, biomass burning and even construction

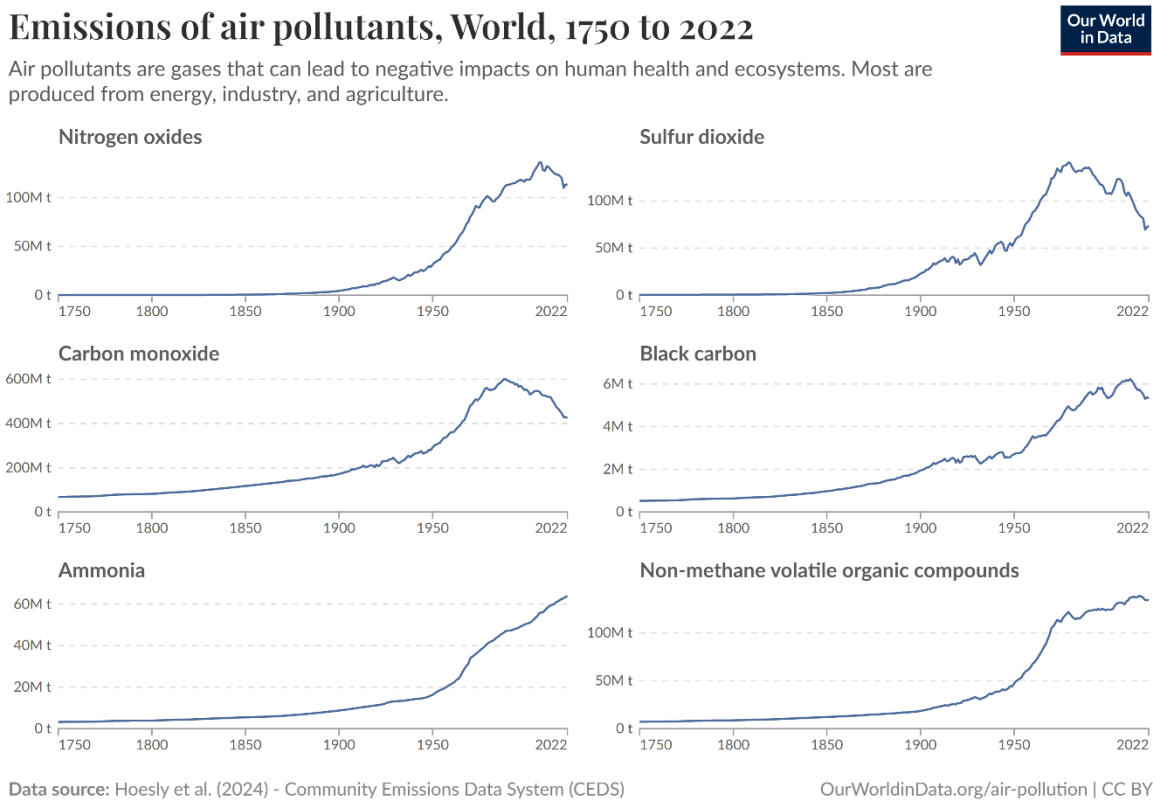
work.[29] Nevertheless, it is hard to compare the scale of the effect as different indexes provide different results: global emission rates seem decreasing through the decades, while air pollutants concentration is increased in certain areas of the world -especially southeast Asia- affecting disproportionally larger populations in absolute numbers than past decades.[30] The least biased index over the course of the current effect of air pollution in human health remains the number of deaths attributed to air pollution yearly, paired with the Disability Adjusted Life Years index, an index which we will examine further in the following chapter. Deaths attributed to air pollution as primary risk factor are still on the rise.

Following diagrams and maps which visualise some of the facts described above:



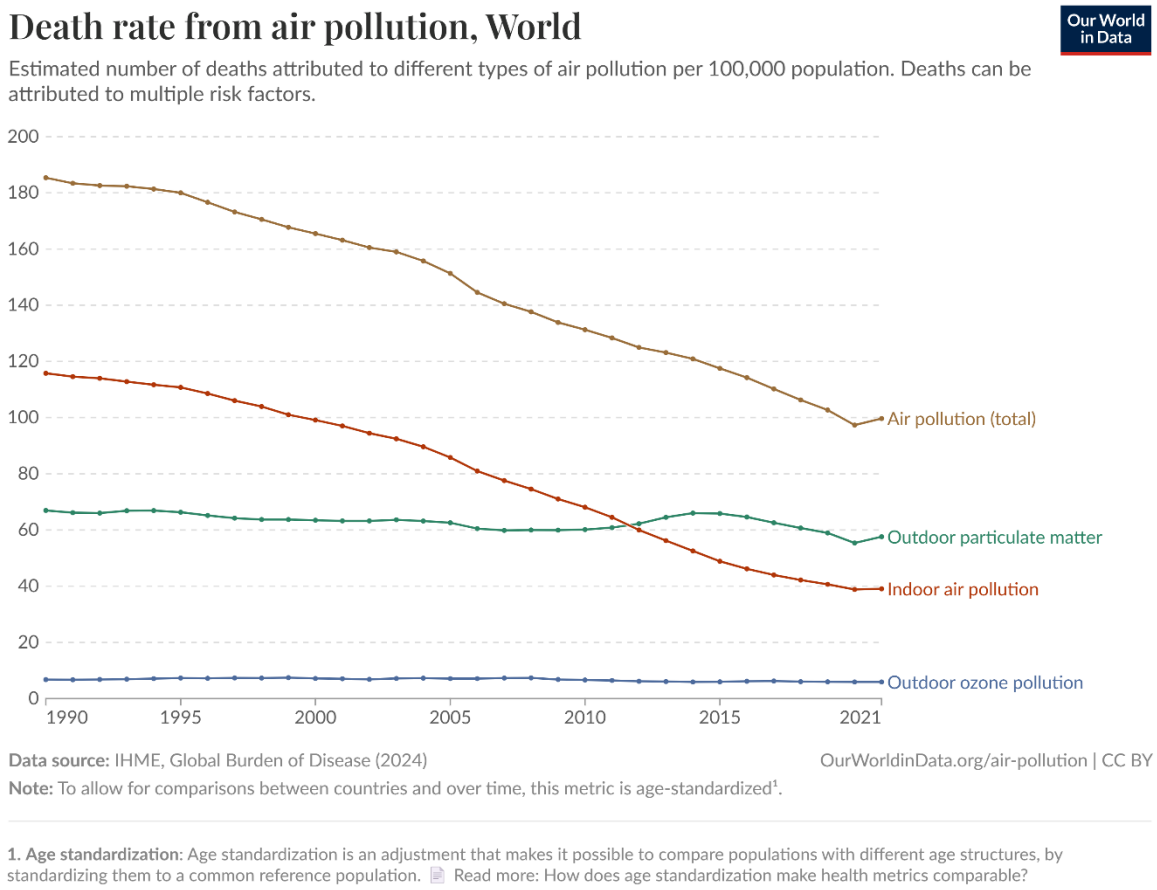
Source: Visualization of data from Institute of Health Metrics and Evaluation (IHME) publication 'Global Burden of Disease' of 2024 by Our World in Data team under the topic of 'Air Pollution'

Political map that depicts the share of deaths attributed to air pollution from the total of reported deaths in each country as of the year 2021. The darker the shade the bigger the percentage of deaths attributed to air pollution. We observe that rates that exceed 12% are more prevalent in Middle and Eastern Asia as well as on the most part of Northern and Middle Africa. The largest shares observed in China and India exceed 18% of the total deaths. The lowest rates are observed in North Americas, Australia and Western and Northern Europe, where they are attributed to a maximum of 3%.



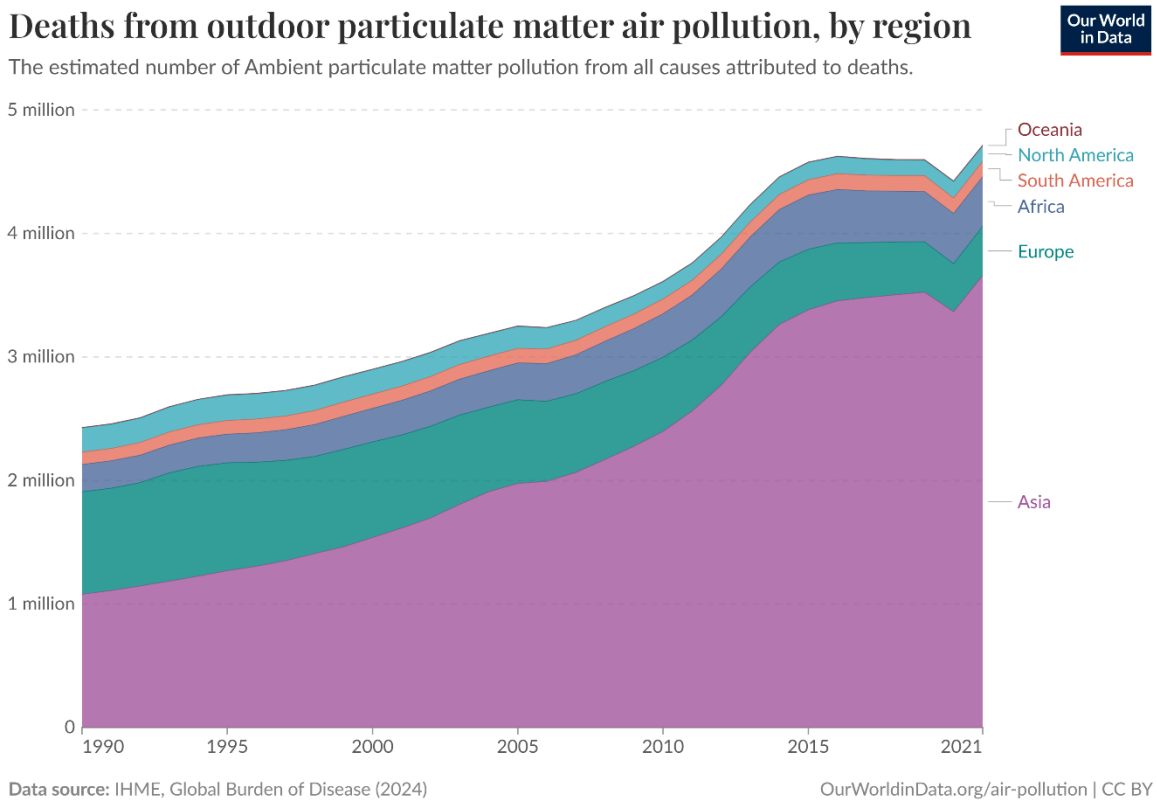
Source: Visualization of data from Community Emissions Data System (CEDS) publication of Hoesly et al. in 2024 by Our World in Data team under the topic of 'Air Pollution'

Multiple line graphs that demonstrate the trend of emission of several gases worldwide that are produced by human activity but affect negatively human health. Vertical axes refer to the amount of gas emission in metric tons and horizontal axes the studied period which begins from 1750 and reaches 2022. In most cases emissions started surging up since 1850's to gain a steeper slope since 1950's. Most types of gases peaked their emissions around the Millenium and started reducing them ever since, albeit the metric tons emitted in 2022 are still double or even triple the size of the recorded level in 1950. Ammonia's emissions are still on the rising curve, while non-methane volatile organic compounds seem as they have reached a stable plateau since 2020.



Source: Visualization of data from Institute of Health Metrics and Evaluation (IHME) publication 'Global Burden of Disease' of 2024 by Our World in Data team under the topic of 'Air Pollution'

Line chart that depicts the rate of deaths attributed to air pollution per 100,000 people globally in the years 1990 to 2021. The three constituents of total air pollution-caused deaths are outdoor particulate matter (green line), indoor air pollution (red line) and outdoor ozone pollution (blue line). Ozone-caused deaths are presented as stable throughout the studied years, being responsible for roughly 10 to 100,000 deaths yearly, as well as particulate matter-caused deaths, which faced a mild peak during 2015 and affect roughly 60 to 100,000 people yearly. The main shift is observed in deaths attributed to indoor air pollution, which have been reduced to 1/3 in 2021 in relation to the 1990 level and now affect roughly 40 to 100,000 people worldwide. Indoor air pollution is caused by ill methods of cooking and heating in households and is especially affecting those with lower income.



Source: Visualization of data from Institute of Health Metrics and Evaluation (IHME) publication 'Global Burden of Disease' of 2024 by Our World in Data team under the topic of 'Air Pollution'

Area chart that indicates the specific burden of deaths attributed to particulate matter air pollution ordered by geographic Continents in a studied period from 1990 to 2021. Vertical axis refers to absolute number of deaths and horizontal axis refers to time. Each colored area refers to deaths attributed to PM air pollution in each Continent, which are calculated by the difference of the lowest and highest limit of the area in each specific time point of the vertical axis. We observe that Oceania constantly has the smallest share, the Americas combined have a stable share of roughly 300,000 annual deaths, Africa has a mild rise as time moves forward while Europe has significantly lowered her share almost by two thirds over the studied years. Asia holds the lion's share with a constant rise that turned steeper after the year 2000 and was only mildly curbed in 2020, probably due to COVID-19 restrictions.

Source: European Environment Agency

Political map of Greece with two colored dots: one yellow over Athens and one orange over Ioannina. According to the appendix, each color represents the level of the particulate matter concentration in the air of the specific area. The air quality in Athens is characterized as moderate and in Ioannina as poor with data as of 2023. There were no available data for other cities in Greece.

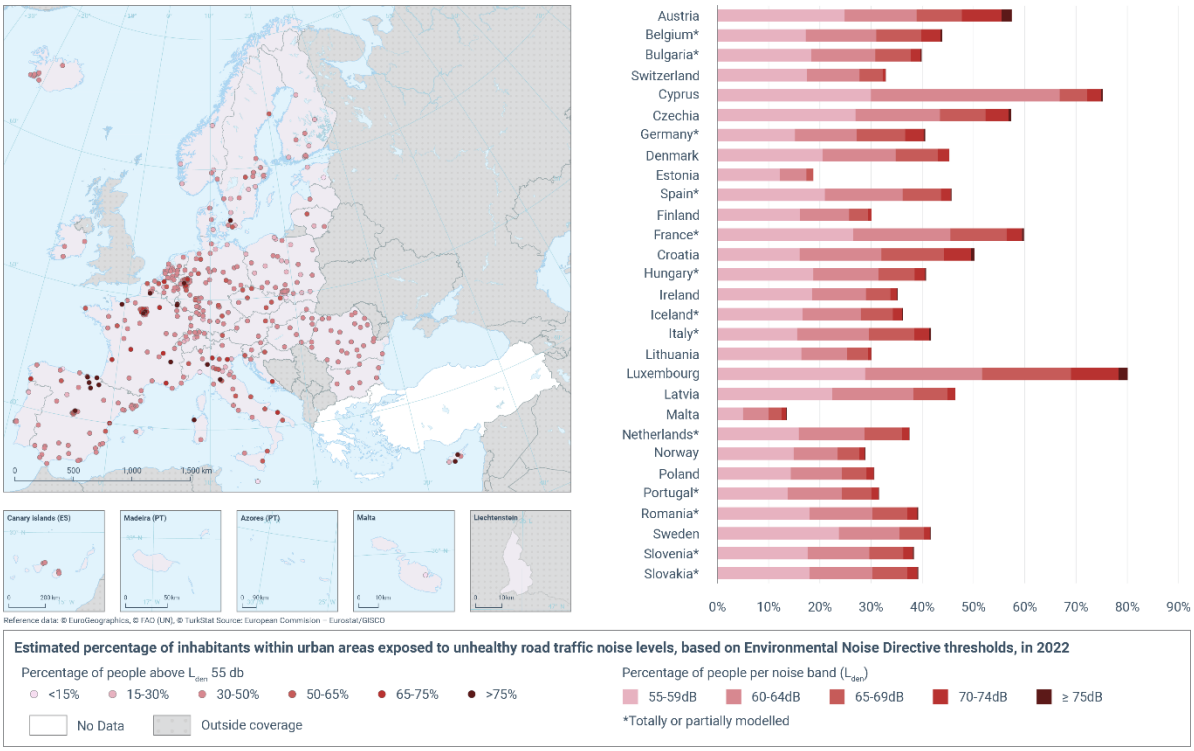
In Europe, second to air pollution stands environmental noise as factor in disability adjusted life years lost (DALY) index.[31] Aircraft, road traffic, construction work, industrial activity and railways are the main 'noise pollutants', so once more, that non-communicable disease risk factor is taking its toll mainly on urbanized areas. Noise is linked to hypertension, strokes, ischemic heart diseases and even cognitive debilitation. Nonetheless, the most obvious consequence of constant noise exposure is the induced hearing loss.[32]

Road traffic specifically is not expected to diminish as car owners are on a rising trend worldwide.[33] Greece in particular has been characterized as world's second most car-dependent nation for 2023 by one privately conducted research, as it has an inefficient and unsafe railroad system, but holds the longest motorway network in Southeastern Europe, with a total length of over 2,000 kilometers.[34]

Similarly, International Civil Aviation Organization (ICAO) has published an estimated projection of global aircraft noise, and it is expected to double by 2050 if not for significant noise reducing technological advancements.[35] This trend also affects Greece as 15 airports - including the Athens' international airport- are undergoing expansions to accommodate the surging amounts of incoming tourists.[36]

Up to this point, measures to tackle environmental noise remain an issue of tertiary importance among European member states, so little progress is or will be achieved in the

near future. The same goes for the rest of the world, even if noise is an identified health threatening issue from WHO, with measurable economic consequences.



Source: European Environment Agency's publication 'Exposure of Europe's population to environmental noise', December 2024

A chart that combines a scattered dots map and a stacked bars chart to illustrate the road traffic noise level in several cities of EU countries. The scattered dots map indicates the noise levels in selected cities across the EU with colored dots, where according to the information appendix below, the darker the shade of the dot, the higher the decibels suffered by its residents. We observe that the noisiest cities are not necessarily the capital cities for each country, which might indicate transport hubs located in the specific regions. The stacked bars chart illustrates the percentage of the population (horizontal axis) of each country (vertical axis) that suffers from noise pollution. Each bar is divided by grading shades to indicate which percentage of the population suffers from specific decibel categorization. The darker the shade, the higher the decibels. We observe that there is no geographic distribution of noise, as neighboring countries have varying noise pollution (e.g. Malta and Italy or Spain and Portugal) but urban residents in Europe are affected in an average of 40% of the population. We also observe that the noisiest cities are not part of the most populous countries (e.g. Cyprus and Luxembourg), so population levels are not enough to justify the results. Other than these, we observe that the degree of noise is evenly distributed in most countries with most residents suffering from 55 to 59 dB, secondly more from 60 to 64 dB and only a 10% fraction from 70 dB and over. Notably, Greece was the only Member State that did not manage to submit any data related to traffic noise pollution, even if it scores very high in car dependency ratios, as already mentioned above.

Source: Mimi's World Hearing Ability Map, 2021

Colored political map that groups several countries by the average hearing ability of their residents. Green colored countries generally have good hearing ability, blue have normal and red have poor. Good and normal hearing ability is reserved only for a handful of countries, while most of Asia, South America and Africa are listed as having poor hearing ability. Greece is grouped with countries who have poor hearing ability. Notably, the data for this categorization were collected by roughly 1,500,000 volunteers who participated at Mimi's data collection hearing tests during 2020, so the credibility of evidence can be judged as limited.

❖ **Work model**

Another risk factor for the manifestation of chronic disease is found in working models: overload imposed on the human body by overwork, which has been stabilized in pro-pandemic levels and indicates a mild rising trend,[37] shift work that has also been associated with manifestation of chronic disease[38], prevalence of part time work contracts and other atypical contracts[39], and expansion of working life duration are all taking a toll on the manifestation and treatment of chronic disease for people who must work to make ends meet worldwide.[40]

Part time work can be indicated both as a cause and a result of chronic disease.

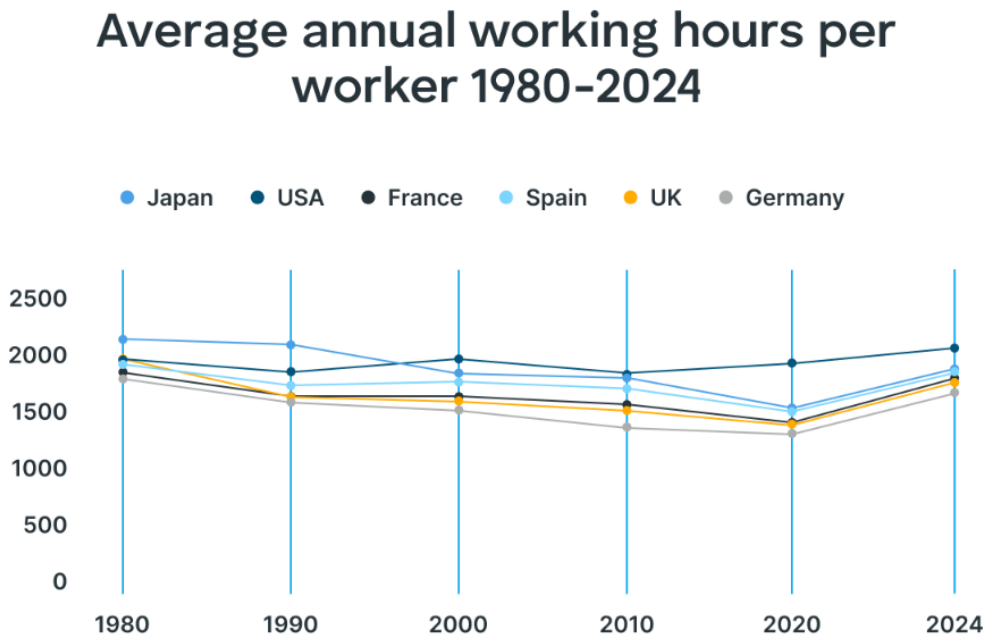
In addition to the facts described above, once a chronic illness is manifested, chronic patients are more likely to be unemployed than fit people, therefore more marginalized and financially deprived.

Greece stands particularly high in the OECD's countries classification per hours worked in 2023. Greece is in the fourth place among all contestants -just below three countries of South America- and in first place among all other Western countries members of OECD, with 1,897 hours worked per person annually.[41] Furthermore, in a census carried out by Eurostat with data as of 2021, Greeks are ranked in the second place after Sweden for the high share of the working population exposed in risk factors for mental health at the

workplace. Specifically, almost 70% of working Greeks evaluate their work as strenuous for their mental health, which ranks Greece amongst the most stressful places for work in the EU.[42]

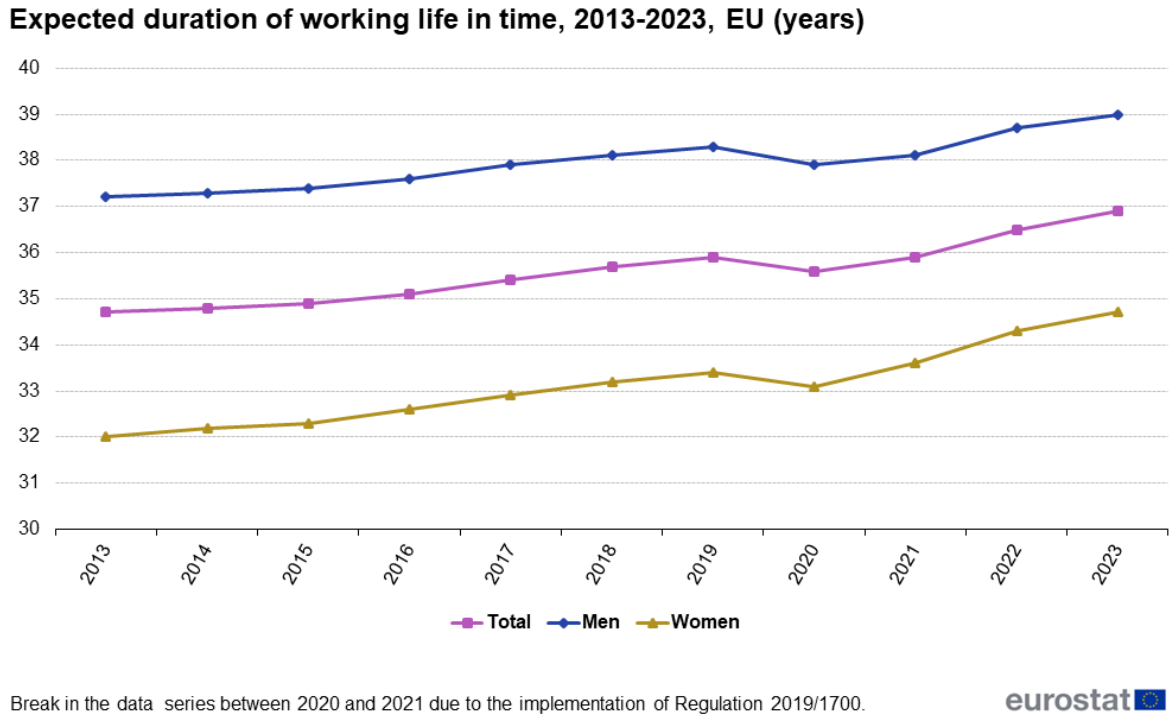
Another worrying factor that relates chronic disease to work is the increasing trend of deaths attributed to occupational cancers. Occupational cancers are related to carcinogenic substances such as asbestos, arsenic, beryllium and benzene. The prevalence of such cancers has been rising worldwide since 1990, with Western Countries taking the heaviest toll, but having the mildest rise in the related deaths. Although yet lower than the West's, since the 90's, the share has doubled for Central Europe and treble for high-income Southeast Asia, which includes Japan, South Korea, Singapore and Brunei.[43] It is striking how that index has not already decreased in the West alongside other risk factors related to manufacturing activity such as air pollution and water pollution.

Following diagrams and maps which visualise some of the facts described above:



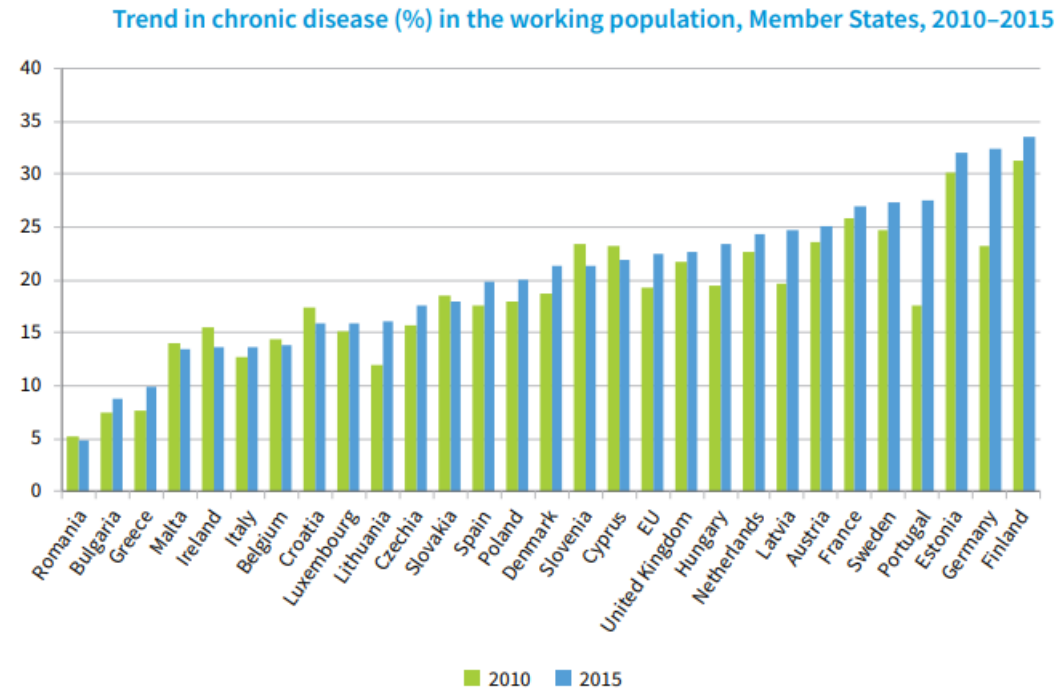
Source: International Labor Organization (ILO)'s data as visualized by Clockify in article 'Average Working Hours (Statistical Data 2025)'

Line chart that displays the trend of average annual working hours per worker in a time frame from 1980 to 2024 for six economically significant countries. While most countries showed progressive decrease from 1980 to 2020, in the USA working hours rose from 1990 to 2000, and then remained stable until 2010 before starting to rise again. In the rest of the countries a rise is observed after 2020 to reach back to the levels of 1980 by 2024. USA are already above the 1980's level of annual average working hours.



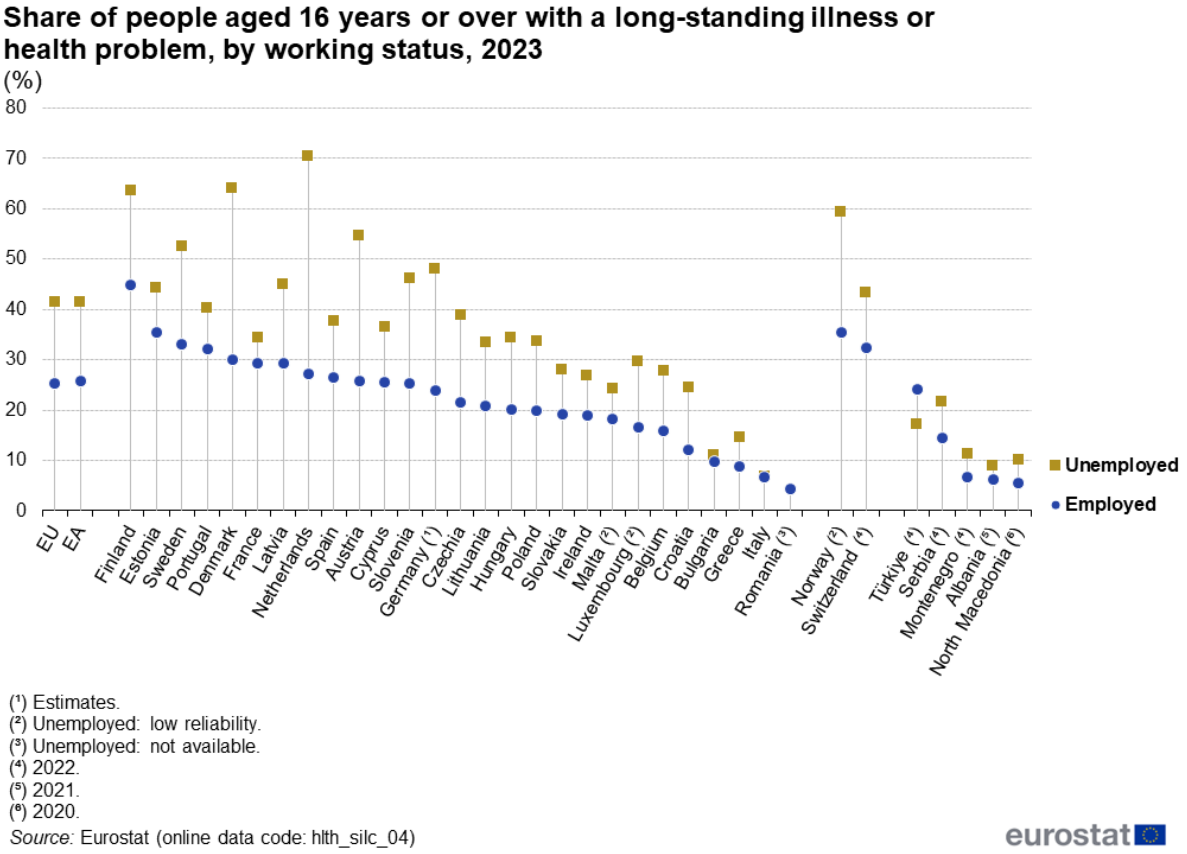
Source: Eurostat's statistical themes of 'Labour market (incl. Labour force survey)' as of June 2024

Line chart that depicts the trend of working life duration in the EU average as shaped from 2013 to 2023. Vertical axis represents duration of working life in years and horizontal axis the studied years. Yellow line refers to women, blue line refers to men and purple line refers to both. We notice a rise in the expected duration of life years from 35 years to 37 years. Working life duration has increased for both sexes whose duration converged during the latest decade, as on 2013 women retired after 32 years of work and men at 37 (5 years difference) and on 2023 women retired after 35 years of work and men after 39 (4 years difference).



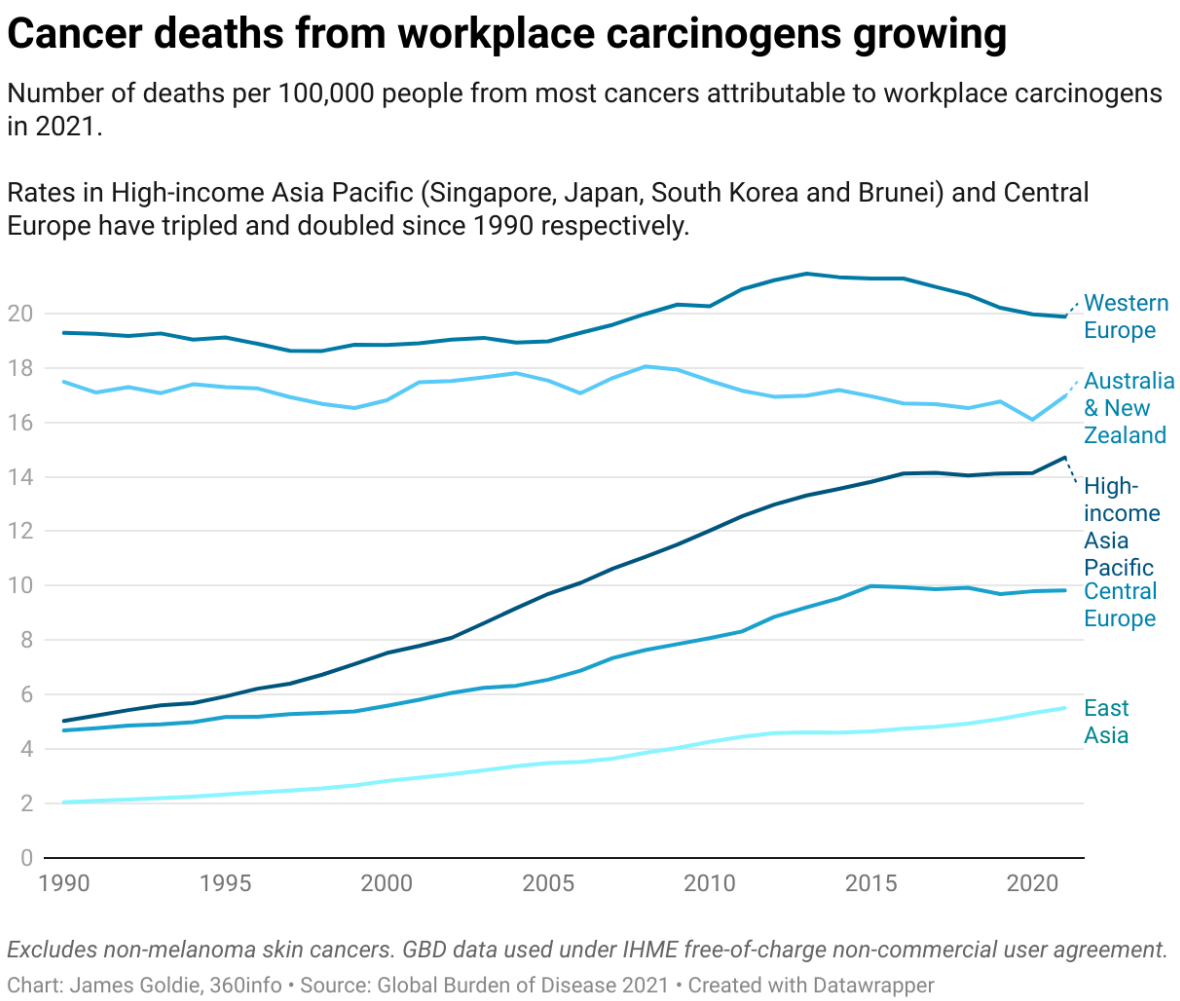
Source: Policy brief publication of Eurofound titled 'How to respond to chronic health problems in the workplace?', 2019

Column chart that compares the percentage of the working population with a chronic disease in 2010 to the same of 2015 for each EU Member State. Vertical axis represents the percentage of the working population while horizontal axis refers to countries. Each country is assigned with a pair of columns: a green one which depicts the percentage of 2010 and a blue one which depicts the percentage of 2015. Except for eight countries, the rest display a bigger or smaller rise in the rate of working population with a chronic disease from 2010 to 2015, increasing the EU average to roughly 5% more. That is the EU average working population with a chronic disease was between 20 and 25% in 2015.



Source: Eurostat's statistical themes of 'Self-perceived health statistics' as of July 2024

Dot plot that depicts the prevalence of chronic disease among employed people and unemployed people in each of the EU's Member States plus a few more for data as of 2023. Vertical axis represents the percentage of the population, which refers to the employed population when associated with the blue dots and to the unemployed population when associated with the brown square dots. For most of the countries, chronic disease is more prevalent among unemployed people -a term which most probably includes pensioners- than in employed people. The reverse image was only noticed in Turkey, while Italy and Bulgaria displayed minor difference between the two groups. The EU average is shaped on 25% of employed population having a chronic disease compared to 40% of the unemployed population on the same rate. Greece displays low rates in both populations with less than 10% of the working population suffering a chronic disease and around 15% of the unemployed. Generally, both rates increase as we move towards the North.



Source: Visualization from the Institute of Health Metrics and Evaluation (IHME) publication of 2021 'Global Burden of Disease' by Down to Earth's article 'Workplace carcinogens increasingly a global problem', October 2024

Line chart that depicts the possibility of dying from one sort of cancer attributed to workplace carcinogens from 1990 to 2020. Vertical axis refers to thousand deaths per 100,000 people, horizontal axis refers to time and blue shades lines to the trend of specific geographic regions as grouped by the author of the article. We observe that Western Europe always comes first and experienced a mild rise from the 2010's to revert to the same level as before this in 2020, that is a little below 20.000 deaths per 100,000 people. Australia and New Zealand have fluctuations but remain rather stable between 16,000 and 18,000. Central Europe doubles its share of occupational cancers' deaths from 1990 to 2020 and Asia Pacific, which includes Japan, Brunei, Singapore and South Korea treble their share.

A disclosure statement is that life span has been extended over the decades, as well as infant mortality has declined, and by that the heredity factor is playing a role of outmost importance in chronic disease manifestation, but heredity will not be thoroughly examined in this body of work.

Burden and cost of chronic disease

Treatment and alleviation of chronic disease patients require significant resources both from the patients' families and the states. It is safe to assume that poorer nations are disproportionally hit by that burden as they gather more patients of chronic disease with much less resources available to assist their needs. As a matter of fact, the loss of lives in these countries due to chronic disease only contributes to their ongoing economic stagnation.[44]

Unrelated to the country of residence is the fact that general healthcare costs are on the rise worldwide and so is the share of out-of-the-pocket expenses of households for healthcare. Out-of-the-pocket expenses refer to the money paid by the patients themselves for medical care services. It is safe to deduce that this condition affects chronic disease patients also, who skip on their needed use of medication and health services.[45] People not having enough resources to have their preventive screenings or even their diagnosed condition's medical care is another harsh reality. Greece is ranked among the higher rates of people not being able to meet their health needs for financial reasons in the EU.

i. Burden from chronic disease on patients

Patients and their caregivers bear a heavy economic brunt, which can even drag them to inextinguishable debt and impoverishment, especially if they are only dependent on labor incomes.[46] Besides the direct cost of medications, hospital admissions, ambulances and other means of transportation related to health treatment and rehabilitation, indirect costs exist as well. Indirect cost refers to the lost/unrealized incomes due to morbidity and premature mortality of the patient or his informal caregiver. For example, even if people with dementia are mostly retired from the working force, their caregivers are not. Nonetheless, they must commit many hours per day to take care of their patient's needs, who is often a close relative, at the expense of having a full-time job and earnings and own mental health.[47] Lastly, we get the intangible cost of the chronic disease which refers to pain, anxiety, suffering, stigmatization and bereavement caused by the chronic disease. The factors of the intangible cost are largely ignored in official national and international studies.

WHO has conducted research which indicates that 20% of Europeans experience catastrophic healthcare expenditure which results in them not meeting their other needs (food, housing etc.) Western Balkans are particularly affected.[48] Greece is ranked second after Bulgaria in out-of-the-pocket healthcare expenses between EU countries.

ii. Cost of chronic disease for the state

The national states worldwide tend to increase public healthcare expenditure in absolute values, even though at different degrees of their national GDP. Chronic disease is certainly contributing a significant share in the rise of funds, which could be described as a direct cost of chronic diseases. Notably, Greece ranks among the lowest shares of expenses for healthcare as a ratio to its GDP among the EU27 member states.

Indirect costs include the loss of produced GDP and deduced tax income due to premature deaths or early retirement and absenteeism attributable to chronic disease. The exact estimate of that economic amount is not publicly updated for the latest decade.[49]

iii. Disability Adjusted Life Years (DALYs)

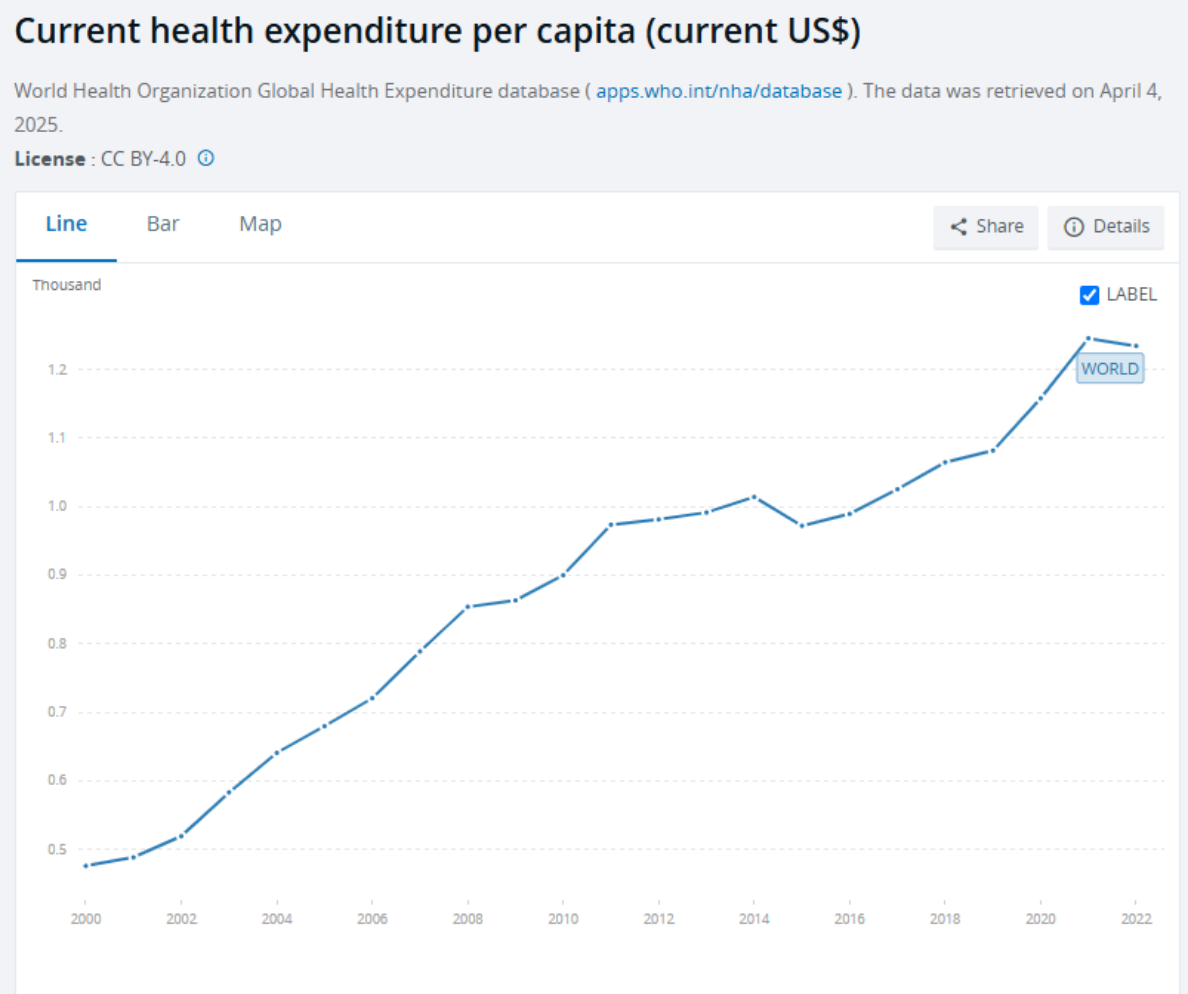
Another rather indirect indicator of chronic disease is the healthy years lost due to illness primarily of the patient and secondarily of his caregivers. The invented index which counts the latter cost is named Disability-Adjusted Life Years (DALYs) and is counted in time fraction of years. According to WHO, the calculation made for DALYs from a specific cause is standardized as follows:

DALYs = years of life lost due to premature mortality (YLLs) + years of life lost due to disability/less-than-full health (YLDs), where life expectancy is estimated at 92 years old.[50]

By this definition, DALY index rather quantifies loss of health than social value of loss of health. The latter is harder to define in an unbiased and ethical manner.

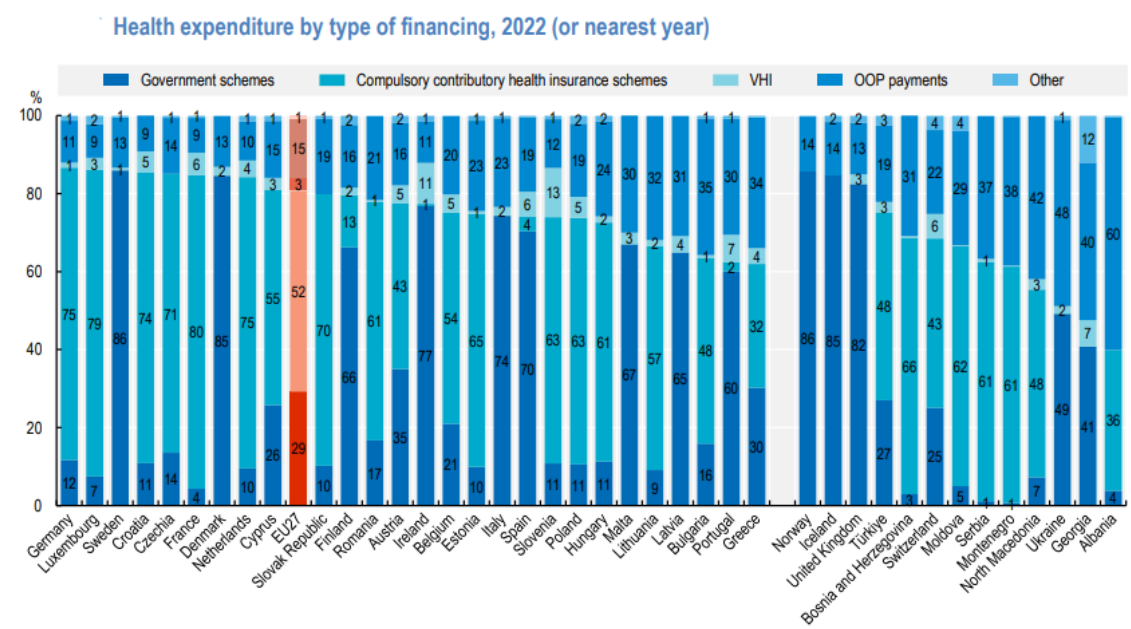
Specifically in Greece, older people report to having slightly less years to live in full health than the EU average.

Following diagrams and maps which visualise the facts described above:



Source: World Bank Group Data visualization of data provided by World Health Organization in April of 2025

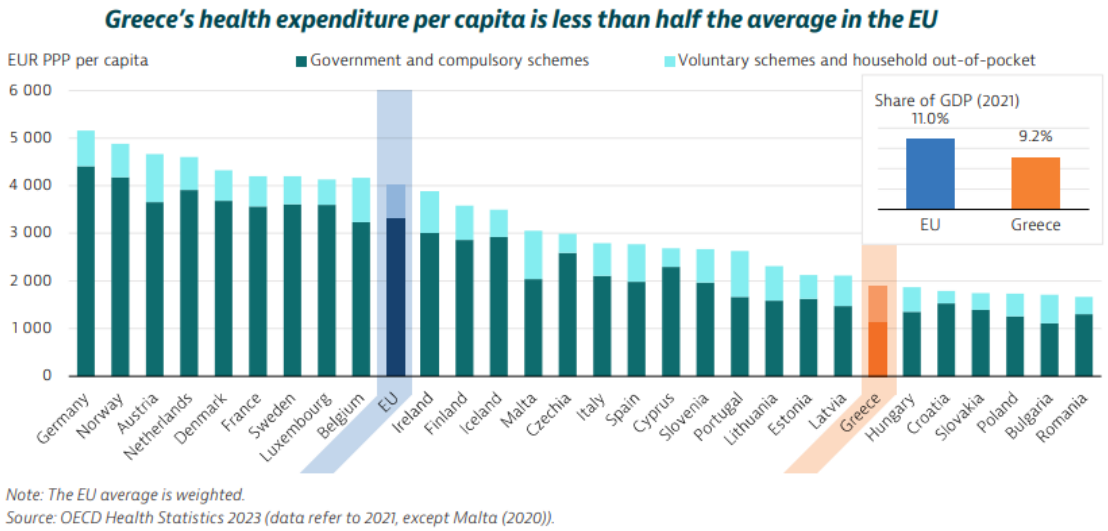
Line chart that depicts the world's trend of the health expenditure per capita in US Dollars as it has evolved from 2000 to 2022. Vertical axis refers to cost in thousand USD and horizontal axis to the years in study. The blue line refers to the average cost of the per capita healthcare services. Despite local fluctuations, the trend is obviously upwards throughout the twenty-three studied years, with the cost of 2023 being more than double of what it was in 2000.



Note: Countries are ranked by government schemes and compulsory health insurance as a share of health expenditure. The EU average is weighted. The "Other" category refers to charities, employers, foreign and undefined schemes. VHI refers to voluntary health insurance. OOP refers to out-of-pocket payments.
Source: OECD Health Statistics 2024; Eurostat (hlth_sha11_hf); WHO Global Health Expenditure Database.

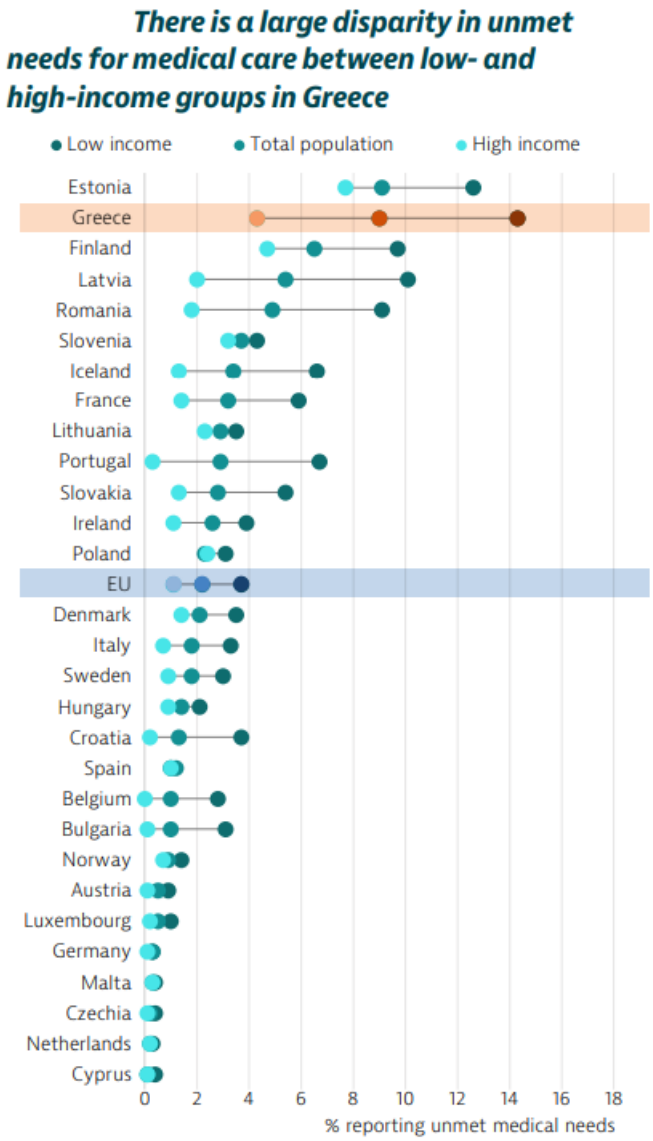
Source: OECD's publication 'Health at a Glance: Europe 2024', November 2024

Stacked bars/columns chart that depicts the division of healthcare expenses by type of financing for various European countries- not just EU Member States as of 2022. Each shade of blue refers to a different source of financing out of five options: government schemes, compulsory contributory health insurance schemes, voluntary health insurance (VHI), out-of-pocket payments (OOP) and other. The specific share for each country is noted on the colored part of the column and each column sums up to 100%. Albeit the differences between the countries and the grey area of which schemes are referring to public expenditures and which on private sector expenditures, the EU average shapes the proportions of main types of financing in health expenditures as 52% originating from compulsory contributory health insurance schemes, 29% from government schemes and 15% from out-of-pocket payments. Interestingly, Greece is laying closely to the government schemes proportion with 30% of its healthcare financing but has the second biggest share after Bulgaria in out-of-pocket payments among all EU Member States, with a score of 34%. Compulsory contributory health insurance schemes are shaped at 32%, lagging 20 percentage points behind the EU average.



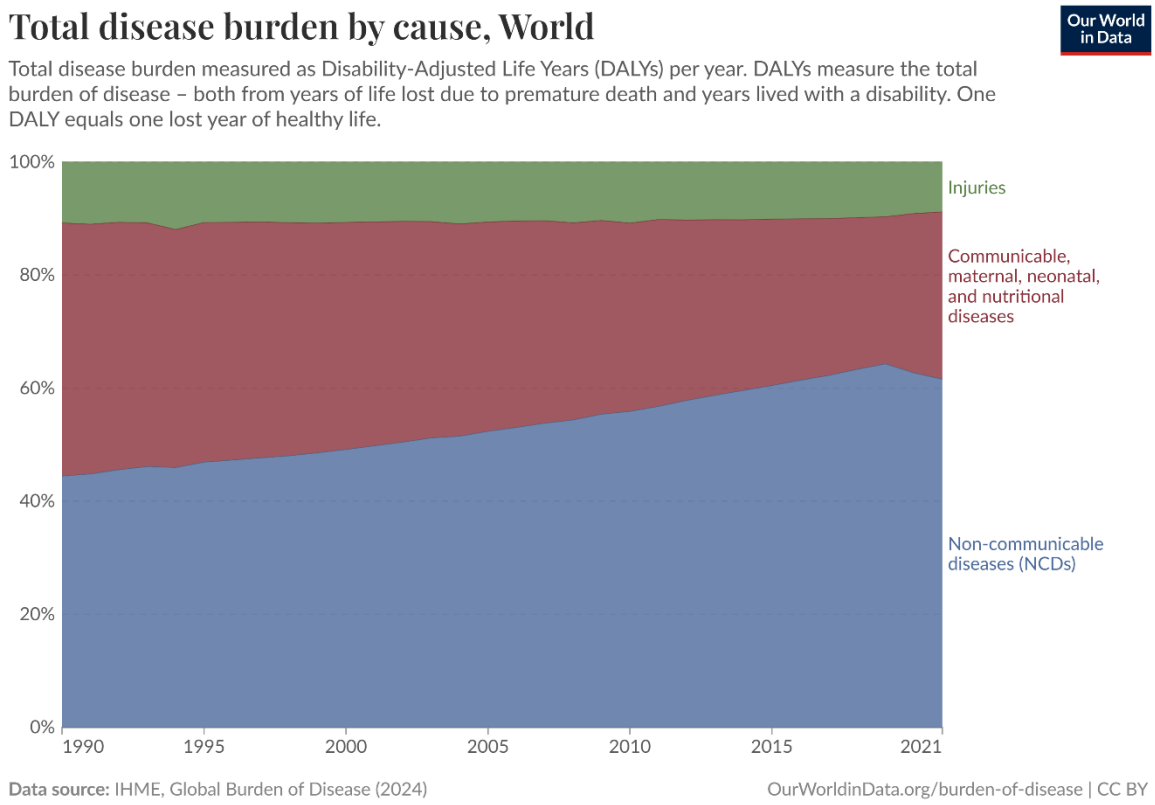
Source: European Commission's State of Health in the EU Greece Country Health Profile 2023

Stacked bars/columns chart that depicts the deflated sum in Euros per capita spent on healthcare in EU Member States in 2021. Vertical axis refers to deflated Euros as PPP stands for Purchasing Power Parity and horizontal axis has listed the countries in scope. Dark green colored part is referring to the sum by government and compulsory schemes while aquamarine part refers to voluntary schemes and out-of-pocket payments. The calculation of each financing sum is the difference between the limits of each part to the vertical axis. We observe that Greece is spending less than half of the EU average on healthcare and significantly less than other countries with less value of gross domestic product, such as Cyprus and Malta. Accordingly, even as a percentage of its GDP, Greece is spending two percentage points less than the EU average which is on 11%.



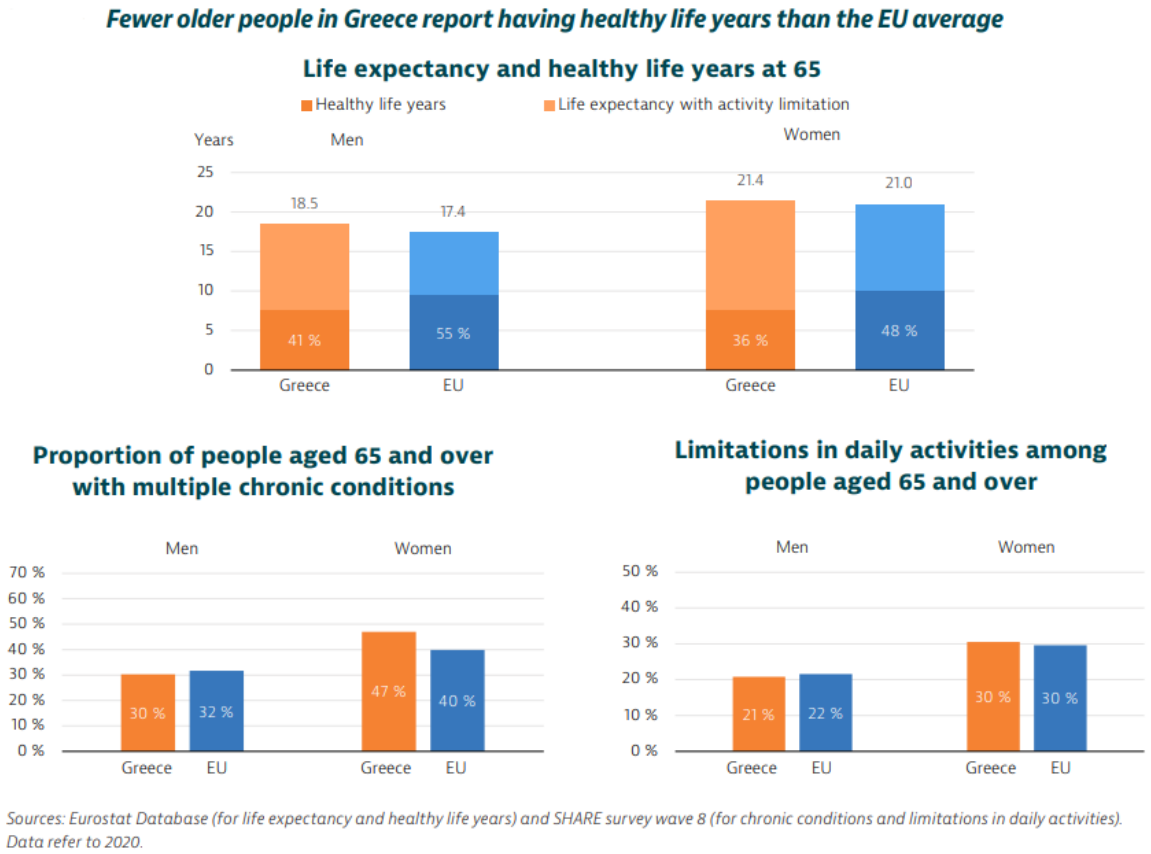
Source: OECD's publication 'State of Health in the EU: Greece Country Health Profile 2023'

Connected dot plot that depicts three different percentages as reported in 2022 for the EU Member States: the share in the general population in each country that does not manage to meet its medical needs in the green dots, the share in the highest income population that cannot meet their medical needs in the aquamarine dots, and the share in the lowest income population that cannot meet their medical needs in dark blue dots. Vertical axis refers to countries while horizontal axis refers to population percentage. We observe that the EU average of people with unmet medical needs shapes to a little more that 2%. Greece strikes the second highest rate after Estonia, with its population who lacks medical service to reach a little beneath 10%. The disparity of the unmet needs between the wealthier population and the most deprived is also among the highest in the EU, that is the highest income population suffers on 4% from unmet medical needs, while in the lowest income population the share rises to 15%. Notably, even the share of the wealthier income not meeting their medical needs in Greece is threefold as big as the EU average, as well as the share of the lowest income.



Source: Visualization from the Institute of Health Metrics and Evaluation (IHME) publication of 2024 'Global Burden of Disease' by Our World in Data team under the topic of 'Burden of Disease'

Area chart that displays the percentage of DALYs attributed to each major category of human health debilitation cause from 1990's to 2021. Vertical axis refers to percentage of attributed DALYs and horizontal axis refers to time. Each colored area refers to injuries (green), communicable diseases, maternal, neonatal and nutritional diseases (red) and non-communicable diseases (blue). The share of each is calculated by the difference of the lowest and highest limit of the area in each specific time point of the vertical axis. All causes together sum to 100%. We observe that NCDs increased their share from a little above 40% in 1990 to 60% in 2021, filling the space left from communicable etc. diseases. Injuries have undergone a slight decrease also, but not to a significant degree (around 5%).



Source: OECD's publication 'State of Health in the EU: Greece Country Health Profile 2023'

Set of column charts that depict information concerning the expected heathy years and the expected life years with disability for Greeks of 65 years of age and older and their comparison to the EU average as reported in 2020. On the top chart we see the expected life years for men on the left and women on the right once they have reached 65 years of age. The lighter colored part of the column refers to life expectancy with activity limitation. The bolder colored part has a number that indicates the percentage of the total of life years expectancy lived in good health. While life expectancy in Greece slightly surpasses the EU average for both males and females, it is a bitter win as elderly Greeks enjoy significantly less healthy years that their EU counterparts (14% less for men and 12% less for women).

Left bottom column chart displays the percentage of people aged 65 and over with multiple chronic condition by dividing men left and women right. We observe that elderly Greek men have a 2% lower chance of developing multiple chronic conditions when compared to their EU counterparts, but elderly Greek women on the other hand are 7% more likely to suffer from multiple chronic conditions. Almost 1 in 2 (47%) elderly Greek women have multiple chronic health conditions.

Lastly, the bottom right column chart displays the percentage of people aged 65 and over with limitations in daily activities, that is in a state of DALY, by dividing men on the left and women on the right. At this case, elderly Greek women are perfectly coordinated with their European counterparts at 30% of their population while men also stand very closely to their European counterparts with only 1% difference in favor of the Greeks (21% for Greeks, 22% for the rest of the Europeans).

Modern policy to tackle chronic disease

As aforementioned, chronic diseases are not studied altogether by the same institutions, neither do all public health units and medical organisations in all countries record and report chronic disease data in a coherent and universally uniform manner. The same principle is valid for the national and international approach towards chronic disease. Only in the 21st century was the attention drawn towards chronic disease. It is only very recently that international organizations such as WHO, European Commission and OECD have recommended action plans for prevention and more efficient control of chronic disease.[51]

Nonetheless, not all national policies follow the expected increasing pace of chronic disease's prevalence. As a result, it is ambivalent whether these people will have their needs met in the future. Emerging research from best practices in higher income countries suggests that the healthcare system should adapt towards a more holistic approach of chronic disease patients[52], but this adaptation requires large sums of investment for a long-term cost-effective result. And by the time these lines are written, the priorities of the world's largest economies are shifted towards trade war and defense expenses, which take a toll on the available income to fund such healthcare adaptation.[53]

From within this contradictory environment, we may distinguish two main pillars regarding the policy measures for chronic disease:

i. Preventive measures

It is empirically proven that campaigns which promote healthier lifestyles on children, adolescents and adults have positive results on the behavioral risk factors associated with chronic disease. So, the key lies in early awareness measures. Such measures may include:

- Advertisements of the benefits of physical activity in the media accompanied by banning advertisements of the use of tobacco and alcohol.
- Increase of the public open walkable spaces in all urban neighborhoods to promote physical exercise.
- Introduction of healthier dietary habits from school to work.
- Coherent information on the whole population over the risk factors that increase the probability of chronic disease in the future.
- Measures for work life balance to decrease stress levels and overall strain.
- Promotion of primary healthcare units instead of hospital centered models.
- Wide spreading information about the importance of regular screenings and other medical exams to assure early detection of any health condition.
- Measures to control air quality and noise levels of urban areas.

The list above is indicative and by no means exhaustive.

ii. Chronic Disease Management (CDM)

Measures of CMD concern patients and healthcare executives once the chronic disease is manifested. So, the proposed approach is to adapt the healthcare system towards a patient centered integrated care model. Therefore, should chronic disease patients have direct links to multidisciplinary physicians since detection of the disease and initial treatment, and once patients exit hospitals, they should receive self-management support and detailed monitoring of health. This approach has proved more effective on the rate of re-admissions

in intensive care units and in patients' overall quality of life. To achieve this goal, the healthcare system must take specific measures:

- Educate the patient on his or her chronic disease condition.
- Build community alliance within neighborhoods' healthcare professionals and other regional social workers' institutions.
- Invest in the technological equipment of the existing healthcare units to allow better information system management. We live in times of Artificial Intelligence utilization in favor of risk factors mitigation and overall health monitoring.[54]
- Invest in healthcare staff's better education around information systems and soft skills that allow remote teleconsultation sessions with patients on a regular basis.
- Allocate the healthcare workforce towards rehabilitation medicine (geriatrics, rheumatology, audiology, ophthalmology etc.)
- Promotion of research and development around innovative rehabilitation techniques.

For once more, the list above is indicative and by no means exhaustive. Nonetheless, the data collected from institutions who apply such measures show high effectiveness with better health for the patients and lower risks of readmission in hospitals.

❖ **Section's summary**

From the facts described about chronic disease it is safe to conclude that it is an ongoing issue that will preoccupy public discourse for many years to come. Prolonged longevity is one key factor that ensures a steady supply of chronic disease patients for the future. Nonetheless, the mortality rate of chronic disease induced deaths, which diminishes in old established economies and progressively does for emerging economies as well. The latest fact implies earlier screenings and better monitoring of chronic diseases, but also a growing number of active chronic disease patients in society.

The rise or stability of risk factors for chronic disease is another factor that will determine the extent of the phenomenon as well as its acuteness. It seems that some health risk factors are on the rise as a country undergoes economic growth and stabilize or decrease as economic growth does too. That fact refers specifically to air pollution. Accordingly acts the mortality rate of chronic disease induced deaths, which diminishes in old established economies and progressively does for emerging economies as well.

On the other hand, other health risk factors are either rising or stabilizing on high shares of the population, such as urban noise, working life stress and obesity.
Those contradictory trends promise a steady inflow of chronic patients in the future. Despite the advanced technology in medical screenings, treatments and pharmaceutical management of chronic diseases, it is also obvious that the social and financial cost deriving from the diseases is also surging worldwide, affecting disproportionally more the poorer nations and the poorer shares of one country's population, who are also more prone to developing a chronic disease.

Greece is seemingly providing high quality services on cancer patients, as derived from relatively low mortality rates, but has negative scores in most other recorded indices (air pollution, noise, working hours, obesity, physical inactivity, tobacco smoking, misuse of antibiotics etc.). Furthermore, the Greek state is scoring among the lower government

expenditures for overall healthcare in the EU, an indicator of exclusion for many deprived citizens from otherwise easily performed screenings for early detection of chronic disease.

Policymakers who try addressing the persistent issue of chronic disease are mainly focusing on preventive measures that will minimize the chances of chronic disease manifestation or help avoid it overall. Additionally, they try to improve a chronic disease patient's quality of life with more holistic approaches which include lifestyle and environmental shifts in the patient's lives. And according to the ongoing research, there is plenty of space to explore new rehabilitation methods for chronic disease patients, as well as for preventive measures. One measure that combines preventive action and chronic disease symptoms alleviation is the green space in urban settings, where risk factors are often more acute than in rural areas.

Before focusing on the greening of urban spaces, we may describe the existing condition of urban spaces and the share of the global population these settings host.

3) Urbanization & urban reform

Urban settlements existed since Ancient Times. Nonetheless, their economic role was by no means as significant as in the latest centuries, neither did they gather most of the regional population. Urbanization has shifted the way of life for a growing share of the population and minimized contact with natural elements, thus creating special environmental conditions that negatively affected human health in newly experienced ways. Restoring contact with nature though increasing urban greenery is suggested to help mitigate health risks for chronic conditions and even climate change consequences by numerous institutions on a national and international level.

At this point we should underline that statistic data referring to urbanization levels globally are highly contested by the fact that the definition of 'urban' differs from one country to another not only on the specific threshold each one sets, but on the metric itself. Some countries adopt population density, others the infrastructure development index, the use of land or the main employment type.[55] To tackle this obstacle, big international institutions (EU, World Bank, ILO, OECD et al.) joined forces and introduced the term of 'Degree of Urbanization' to distinguish cities, towns and villages for statistical comparison. The official definition of the metric as given by Eurostat states "the degree of urbanization classifies local administrative units (LAUs) as cities, towns and suburbs or rural areas (is) based on a combination of geographical contiguity and population density, measured by minimum population thresholds applied to 1 km² population grid cells; each LAU belongs exclusively to one of these three classes." [56] The UN adopted this metric only by 2020. Using high-definition satellite imagery and census information provided by each country, the Global Human Settlement Layer (GHSL) project of the European Commission estimates that 45% of people live in cities and an additional 35% live in towns. These rates combined together make up to 80% of the global population that lives in densely populated urban settlements.

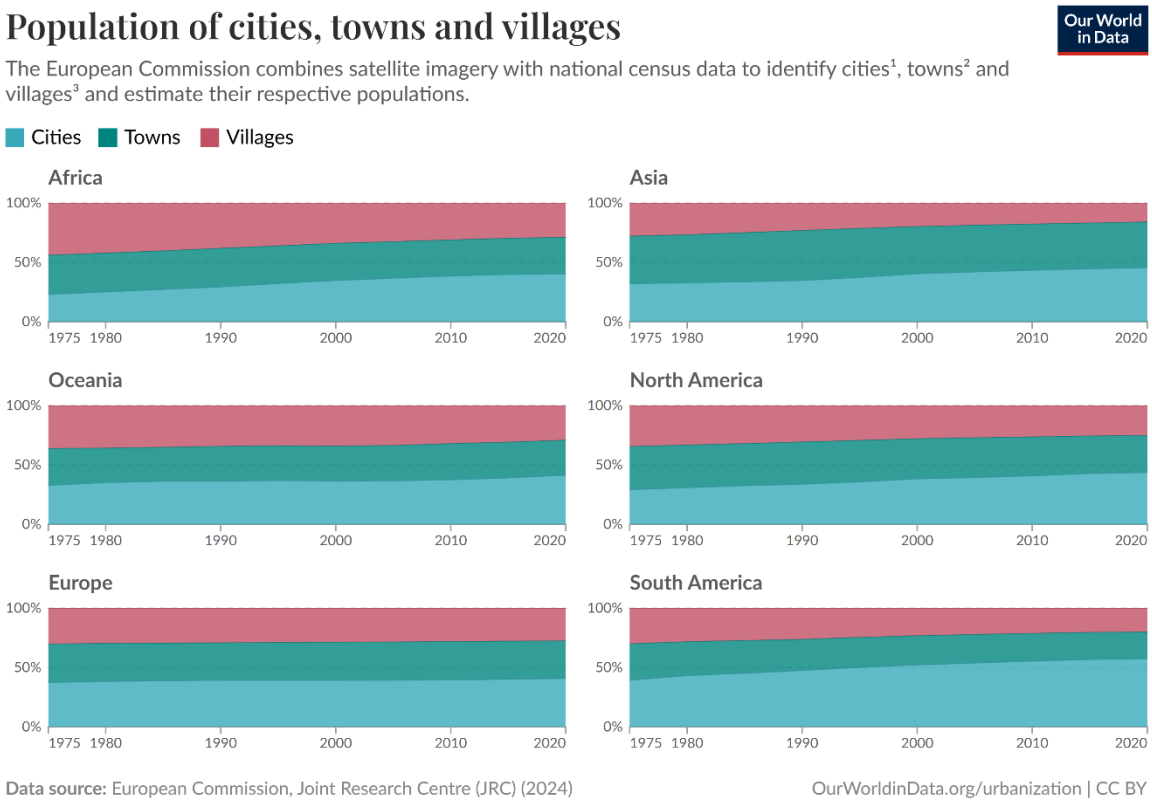
Urbanization as a term is first found written in 1808 to describe the growth of American cities, albeit less than 3% of world's population was living in cities of 20,000 habitats or more in the 19th century.[57] Technological advancements and economic necessities have made possible the migration of large populations from rural areas to urban centers, a phenomenon described as Rural Flight. In the present tense, around 80% of the global population lives in urban settlements and that rate is expected to rise even more. So, urbanization refers to the relative increase of the population and economic significance of

urban areas in comparison to rural areas. Urban growth in absolute terms is also implied while using the word 'urbanization'.[58] Urbanization was presented in 2019 as one of the four demographic mega-trends that would preoccupy the policies of the future according to United Nations' projection – the rest three are growing global population, aging global population and growing international migration.[59]

Another originality of our times is the unprecedent homogeneity in the means of production and living, especially in urban environment. That means that no matter where in the world we choose to record the urban way of living, we will notice that the buildings are built from the same materials, the means of transport are the same, the worn apparel is the same, the means of entertainment are the same and eventually the same risk factors of chronic disease incidence and prevalence are accordingly present. The use of the word 'same' does not indicate similarity, but rather identity. The exact same means are used anywhere in large cities worldwide.

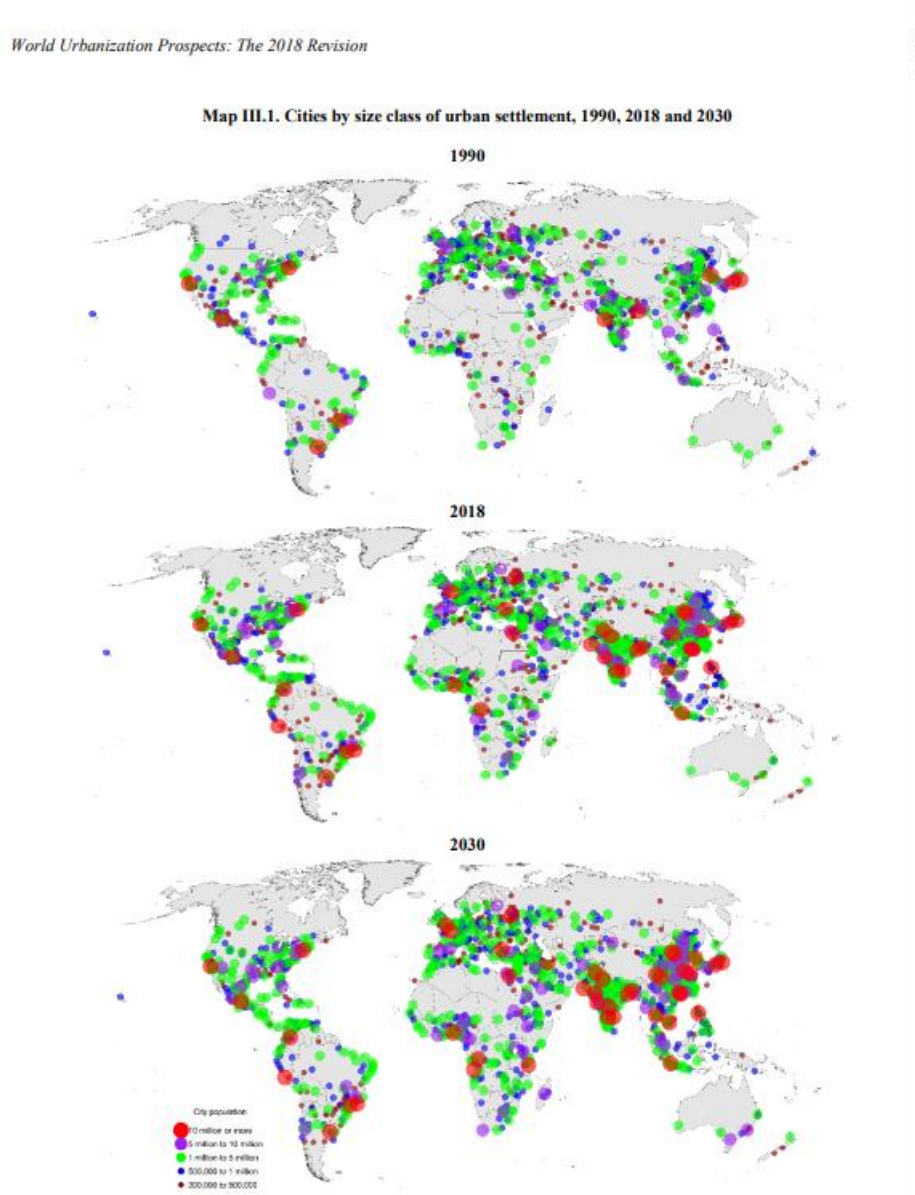
What differentiates one city from another is the urban planning it follows (or the lack of it), the architecture, the industries that develop around it, its special geographic characteristics, the measures it takes for sanitation, its waste management, etc. We need to delve into the possible combinations of these factors, on the effects they have on human health of the general population and on chronic disease patients specifically. It is largely admitted that common risk factors for chronic disease are more prevalent in urban environments.[60]

Following diagrams and maps which visualise some of the facts described above:



Source: Visualization of data from European Commission's Joint Research Centre of 2024 by Our World in Data team under the topic of 'Urbanization'

A series of area charts that demonstrate the distribution of the population in each geographical Continent with data from 1975 to 2020. Each colored area refers to the percentage of the population living in one of the three specified residential agglomerations, which is calculated by the difference of the lowest and highest limit of the area in each specific time point of the vertical axis. Red shapes refer to people living in villages, green to people living in towns and blue to people living in cities. We firstly observe that the share of towns throughout the studied decades has remained mostly stable in most regions except for the Americas where it loses grounds to cities as we move towards 2020. Secondly, we observe the proportionate increase of the share of cities in all continents to the decrease of the share of villages and, in the case of Americas, of towns. The shift is more intense in South America, Asia and Africa while Europe and Oceania are only imperceptibly affected.



Source: United Nation's Department of Economic and Social Affairs (DESA)'s publication 'World Urbanization Prospects: The 2018 Revision'

Proportional symbol map that visualizes the trend of growing cities in number and population from 19090 to 2018 and the projection in 2030. Colored circles symbolize cities with specific population range and the bigger the circle, the larger population of that city. We observe that from 1990 to 2018 cities multiplied in number and population mostly in Europe and Southeast Asia (mostly in size) as well as South America and Africa (both size and number). For the projected future, further agglomeration is expected in Africa and East Asia while the rest of the world is remaining stable

Challenges associated with urbanization

Even if it is undebatable that life expectancy increased dramatically during the 'urbanization phase' of human history, it is equally undebatable that this achievement was accompanied by new challenges that people never considered in the past. One of which is the rise in chronic diseases with all the consequences we have discussed already.

The debate about climate change and biodiversity decline as an effect of urbanization or the sustainability of natural resources management for megacities, will not be unfolded in this overview, even though these aspects concern the 'greening' policies that are being implemented worldwide.

We can list a few urban-specific indices and phenomena that affect human health and are closely related to the differentiating factors between one city and another:

- Floor Area Ratio (FAR) is an index of urban building density which is the fraction of the total usable area of a building to the lot space where the building stands. The higher it is, the more densely built an area is.[61]
- Urban Heat Island (UHI) effect: a meteorological phenomenon where the temperature in urban areas is up to 10 degrees Celsius higher than its surrounding rural areas, both in the day and night. UHI affects also the air quality. This phenomenon is associated with concealed surfaces from heat absorbent materials such as asphalt for roads and cement for buildings. Aggravating factors are the size of the city sprawl, the unruly urban planning where wind streams cannot breeze and lower the temperature, and building size, since the larger the building the more heat it absorbs, the building density, the energy sustainability of the buildings which may emit more excess heat, reduced numbers of trees, and the traffic congestion which emits even more heat.[62] UHI increases the strain of heat stress experienced from urban dwellers. Athens, Greece is also experiencing severe UHI effect as temperature rises close to 10 degrees Celsius more in the metropolitan area in comparison to neighboring suburbs. This is attributed to the size of the buildings, the dense construction, the high solar radiation and the almost complete lack of natural vegetation.[63] Higher air temperatures are linked to increased morbidity and mortality as they cause exhaustion, heat strokes and aggravation in renal, pulmonary and cardiovascular disease.[64]
- Outdoor solar access: Solar access describes the amount and distribution of sunlight in living environments.[65] Sunlight access is crucial for the wellbeing of city residents, as it is recorded to kill germs, improve mood, increase vitamin D in blood, boost immune system and prevent chronic disease.[66] As cities grow more dense in buildings, urban planners neglect the sunlight access effect, so many city dwellers lack its beneficiary effects.
- Sky view factor (SVF) represents the fraction of the visible sky of one's standpoint in space to the total sky area of the horizon. When this factor rises inside urban areas (approaches 1), it is related to cooling effects. On the contrary, when it rises in green environments, it is associated with warming.[67]When it approaches 0, it has the reverse effects for both environments.
- Urban street canyons refer to the urban-specific topography of areas flanked by tall buildings on both sides. These areas develop special microclimates as they modify natural wind speed and direction, affecting eventually the local temperature and air quality. If urban planners do not take into consideration the street canyon effects, it is likely that poor ventilation will lead to accumulation of air pollutants and the heat island effect will be fiercer at that place.[68]

- Pedestrian comfort or walkability refers to the unprecedent in human history indicator of urban area citizens being able to walk around their settlement, or any other area in the city. As cities grow more densely constructed and traffic congested, streets turn into hostile traps for pedestrians. More specifically, infrastructural factors that deter someone from walking are limited sidewalks, poor public space lighting, feeling of unsafety, dull surroundings, lack of accessibility infrastructures for people with disabilities, noise, bad air quality and overheating. Pedestrians are particularly at risk of traffic injuries.[69] Athens Greece has a notoriously unwelcoming state of sidewalks and pedestrianized streets, but proximity to places of interest as commercial shops and schools.[70] It is suggested that walkable cities help improve metabolic health risks as diabetes, obesity and high blood pressure,[71] in a direct way, as people engage in the physical activity of walking, and in an indirect way as less road traffic means less air and noise pollution.[72]
- Waste management is another modern challenge for the urban lifestyle. Solid waste must be transferred outside of the cities where it is either disposed in open landfills, or buried, the latter being the riskier option for soil and water pollution with dangerous toxic substances for human health, or burned in incinerators causing air pollution.[73] World Bank predicts the produced waste to grow by 70% by 2050, unless urgent action is taken.[74] A subcategory of waste is wastewater, which is a product of household and industrial activities or a rainwater outflow from urban areas. Wastewater must be treated with disinfectants before disposal, to protect the public health and the environment.[75] Greece is lagging on solid waste management methods in terms of promoting landfills instead of recycling,[76] but has accomplished the connection of the 91% of the population to an urban wastewater treatment plant.[77]

From all the above, it is easily deducted that urban environment has significant differences in comparison to the natural environment in which man evolved and mostly lived until relatively recent human history.

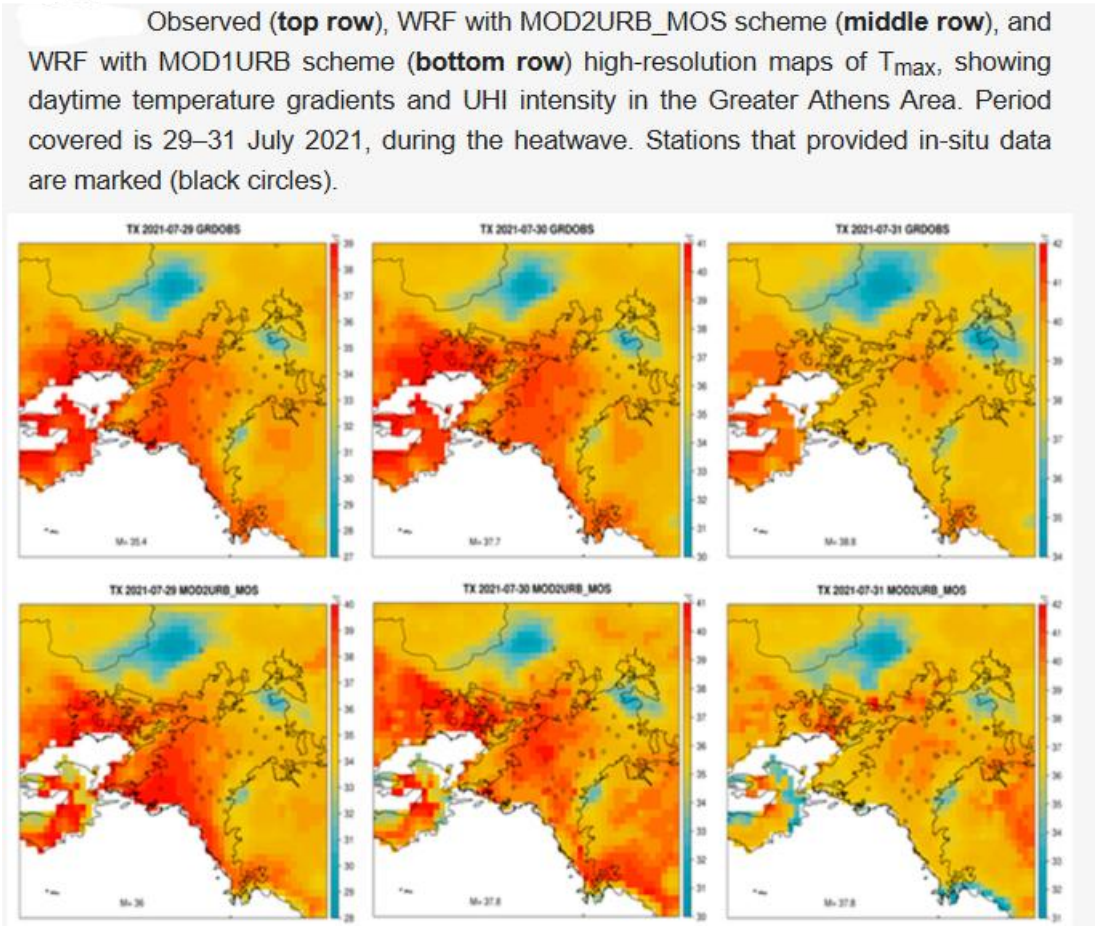
As far as Greece is concerned, a survey was conducted in 2023 where a questionnaire about health statistics of residents and health awareness campaigns was distributed to all 333 municipalities of Greece, out of which only 86 responded. Out of the whole, it was proven that the majority of the municipalities did not track key health risk factors related to their residents' health. However intriguing the results are, it is not clear whether the municipalities that answered consisted of urban areas.[78]

Proposed solutions to these challenges combine a delineation of regulation policies along with central urban planning that focuses on the promotion of wellbeing in the cities for the most part of their population possible. Such solution could be zoning regulation and subdivision control, urban growth boundaries, incentive programs, land conservation legislation, reshaping public infrastructure etc. Zoning regulations divide the land use of urban activities into different zones and may introduce legal limits to significant measures of the urban buildings to be manufactured in each zone as per height, width, density etc.[79] In that manner residential areas, industrial areas and commercial/recreational are set distinct, and the population density is controlled as well. Altogether with achieving high standards of wellbeing for the city's residents. Notably, strict zoning policies have been accused of their efficiency in wellbeing by means of increasing traffic and commuting times and dehumanizing communities, proving that not all proposed solutions are universally accepted.[80]

A great load of urban planning is placed on the central government who must constantly reshape public infrastructure and even erect housing facilities or other public facilities such as hospitals and schools to better accommodate its urban dwellers. Even regulations and incentive programs which promote sustainable construction and development for private manufacturers are all administered by the central government.

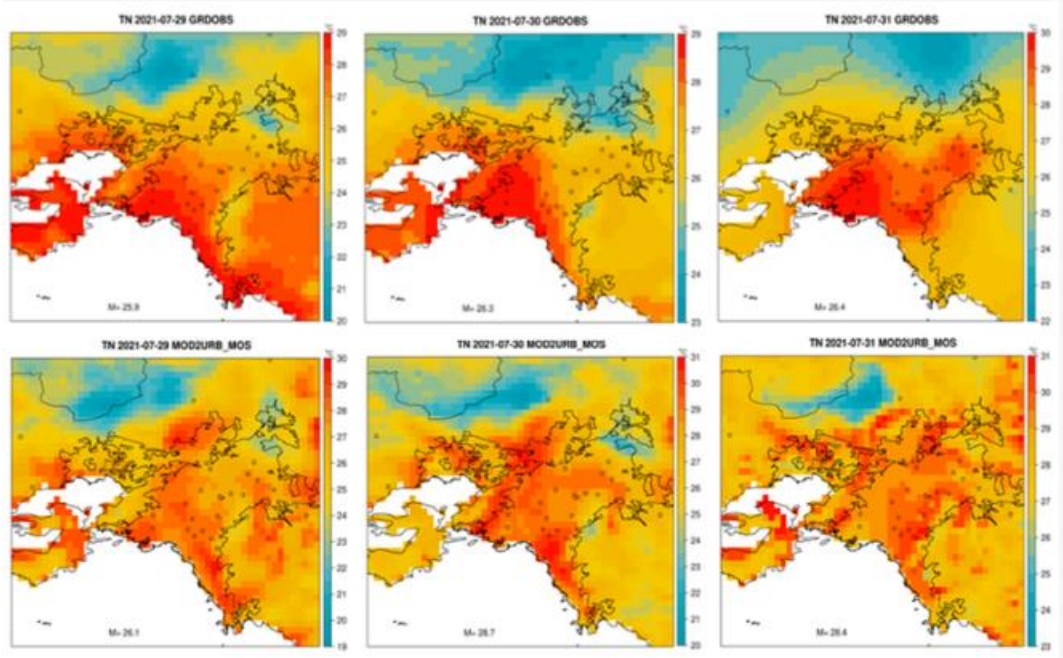
As far as Greece is concerned, urban planning has been rather weak post-Civil War, allowing the urban centers to grow congested, in mixed use land and deprived of urban amenities.[81] Urban sprawling has been unorderly for urban centers and was only later included in the city's plan in many cases. As of 2023, Eurostat ranked Athens Greece among the four capital cities of EU with population density of more than 1,000 inhabitants per km².[82]Additionally to this, even today industrial accidents of large scale are threatening residential areas that are incorporated in the cities' urban planning, very close to the center of Athens.[83] Furthermore, the General Building Construction Code protects very limited open and green spaces.[84] The Workers Housing Organization itself was rather subsidizing rents and loans for sales of houses instead of planning and building housing complexes, before seizing to exist in 2012.[85] Latest data indicates that only 2.9% of land in the EU is used for residential purposes, on average. For the region of Attica that metric spikes to 10.7%.

Following diagrams and maps which visualise some of the facts described above:



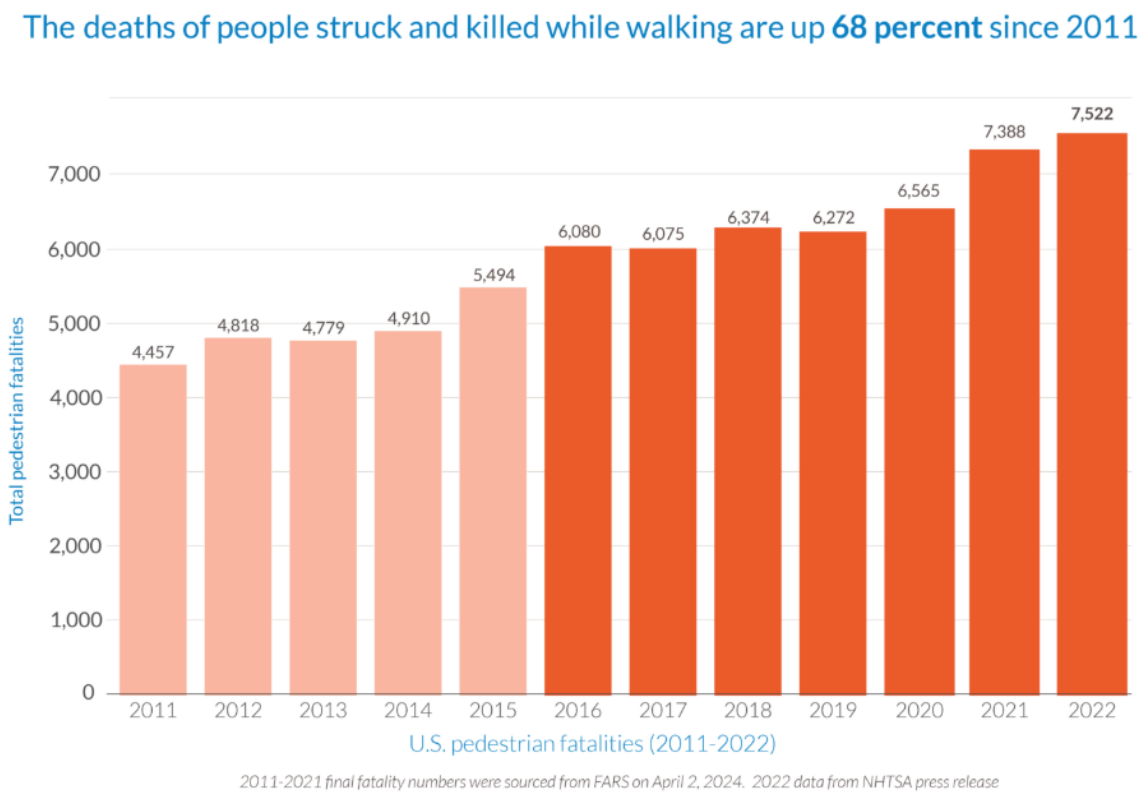
Observed (**top row**), WRF with MOD2URB_MOS scheme (**middle row**), and WRF with MOD1URB scheme (**bottom row**) high-resolution maps of T_{max}, showing daytime temperature gradients and UHI intensity in the Greater Athens Area. Period covered is 29–31 July 2021, during the heatwave. Stations that provided in-situ data are marked (black circles).

Observed (**top row**), WRF with MOD2URB_MOS scheme (**middle row**), and WRF with MOD1URB scheme (**bottom row**) high-resolution maps of T_{min}, showing nighttime temperature gradients and UHI intensity in the Greater Athens Area. Period covered is 29–31 July 2021, during the heat wave. Stations that provided in-situ data are marked (black circles).



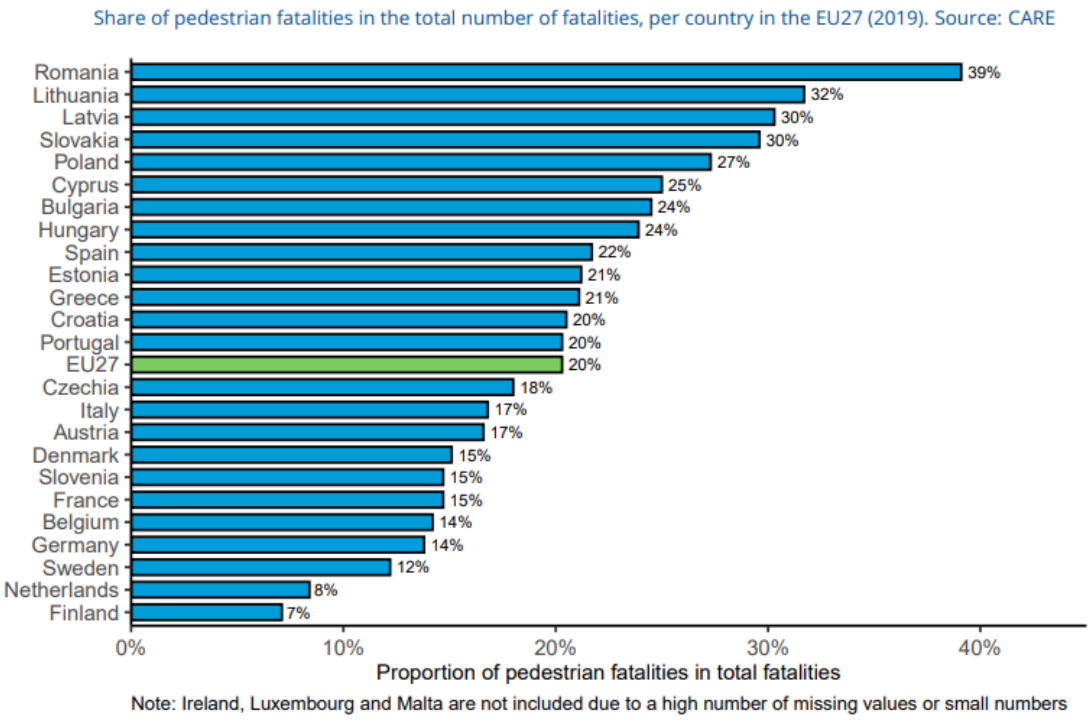
Source: Research article in MDPI titled 'High Resolution WRF Modelling of Extreme Heat Events and Mapping of the Urban Heat Island Characteristics in Athens, Greece', December 2023

Set of geographical heatmaps that demonstrate the temperatures of Greater Athens Area for three days during a heatwave (29 to 31 of July 2021), the top for daytime and the bottom for nighttime. The coloring scale is set from bluer for the cooler parts to redder for the hotter parts. The images were produced using weather research and forecast models (WRF), each row pair with a different one. We observe the Urban Heat Island effect in all images regardless of the time of the day, with the center of Athens as well as its southwestern and northeastern suburbs to stand in almost 40 degrees Celsius constantly, unable to cool off during the night.



Source: Article 'Pedestrian fatalities at historic high', in Smart Growth America published on April 3, 2024

Column chart depicting the pedestrian fatalities caused by vehicles in the USA in a period from 2011 to 2022. Vertical axis demonstrates the absolute number of deaths and horizontal axis the years. We observe that despite the fluctuations, streets have grown into more dangerous places for pedestrian users, as the trend of casualties is rising and in 2022 it has increased by 45%. That is from 4,457 in 2011 to 7,522 in 2022.



Source: European Commission's publication 'European Road Safety Observatory Facts and Figures – Pedestrians – 2023'

Bar chart that depicts the share of pedestrian fatalities in the total number of fatalities for the EU Member States in 2019. Horizontal axis refers to the percentage of the total fatalities and vertical axis has listed the EU countries by decreasing percentage of pedestrian fatalities order. We observe that the trend is the bigger the GDP of a country, the less likely for its pedestrians to be accidentally killed in the street. The EU average is on 20% and Greece is placed a little above, on 21%. Interestingly enough, pedestrian fatalities are an important cause of fatality -that is on or above 15%- for 22 out of the 27 countries in scope.

Urban greening policies

Greening policies are a ratification of central policies who aim at reducing greenhouse gases' emissions and reinforcing the sustainability of large cities, that is their energy self-sufficiency and lower energy consumption, since urban greenery provides insulation against heat and thus reduces energy costs.[86] The amelioration of the urban residents' lifestyle was not a priority, albeit it is a positive side effect.

According to OECD, promotion of green urban growth helps fulfil the sustainable development goal of making cities and human settlements inclusive, safe, resilient and sustainable, as stated in the list of 17 goals of United Nations for sustainable development.[87] Member states of OECD are urged to promote private green infrastructure by providing financial benefits such as reduced property taxes and intermunicipal cooperation schemes.[88]

According to the European Environment Agency, green infrastructure includes allotments, private gardens, parks, street trees, water and wetlands and make up 42% of the total city's

area for the EU average. Nonetheless, the publicly accessible green areas are only 3% of the city's total area on average, even though health benefits of green spaces are renowned.[89] Athens, Greece, scores one of the lowest green infrastructure coverages in the EU which lies under 20% for the total city area. But not only Greeks are affected by the lack of proximity to accessible green spaces in the EU. Research based on data from 2012, affirmed that less than half of the EU's capital cities population meets the WHO's recommendation for access to green spaces within 300 meters of the place of residence.[90] In the same research Greece is negatively pinpointed towards this unmet target for another reason, as in the city of Heraklion less than the 20% of population has access to green space within 300 meters.

More specifically for the European Union, the European Commission has published proposed strategy for biodiversity and infrastructure since 2013 with the latest version setting targets for 2030.[91] Alongside other targets of the Strategy, lie measures for the increase of natural escapes inside urban environment, with an urban nature platform dedicated on this purpose.[92] Except for networking with local authorities, this platform serves as an information hub for best practices from successful green infrastructure policies within EU countries, and information for available funding for such actions. Green infrastructure projects are mainly funded by the LIFE (acronym for the financing instrument for the environment in French) program, European Investment Bank and structural and cohesion funds. More than 400 EU projects were funded by the Horizon2020 scheme and these projects had reference to green infrastructure, the term that includes urban greenery, even though it is not clear how many of them referred to urban greenery.[93] Certainly, the urban greening is not a high priority at the moment, among the rest "Green" projects that refer to energy efficiency and resilience. Greece spends most of the available funding on renewable resource energy investments.[94]

Outside the EU, the rest of the world addresses the urban greening issue with slightly different terms, that is as urban greening policies are not a byproduct of energy efficiency and resilience policies- which makes sense as not all regions in the world depend on imported fossil fuels for energy production- but rather as a tool for social cohesion and inclusion. In this view, USA relies largely on private donations for pocket parks and other green infrastructure improvements in the place of brownfields or other sorts of land that is not suitable for commercial use.[95] On the other hand, many Asian countries are investing in 'green' policies at the moment,[96] but available data indicate that large Asian cities are in the majority lagging behind European cities in terms of green space.[97]

In the case of China, China mobilizes large funds in greening policies in and around the cities.[98] Notably, China's greening policies emphasize on the energy resilience and carbon emission reduction, which seemingly converges to the EU's policies. Nonetheless, and due to its population's size, China's plans on increasing per capita urban green space are expected to affect millions of people.[99] Indicative of that trend is the shift of the administration of green land from Construction Ministry to Ministry of Natural Resources.[100]

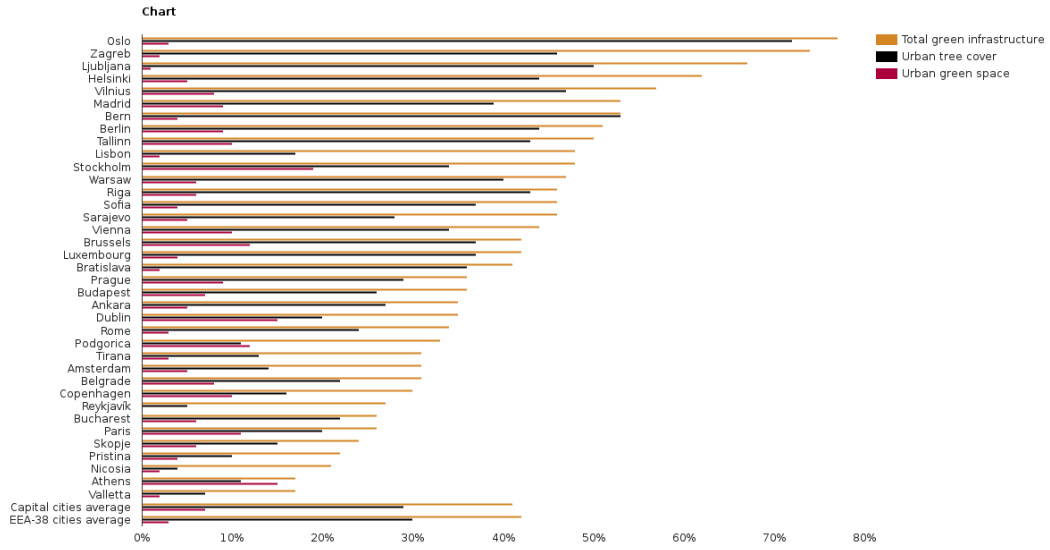
An action plan from World Health Organization's European regional office in 2017, summarizes key interventions in urban space that can help regenerate green spaces and are quoted as following:[101]

- roadside greenery and vegetation barriers along streets or rail tracks.
- small urban green spaces (such as gardens or pocket parks) and playgrounds
- green roofs and facades

- parks and urban meadows
- greenways and corridors (such as green trails for walking/cycling)
- coastal, riverside or lakeside trails, linking green with blue spaces
- recreational and urban gardening facilities (such as community gardens, sport and play areas and school grounds)
- facilitated access to urban woodlands, forests and natural wildlife areas.

Despite the growing interest in urban greening and its beneficiary effects, a private research run by the Husqvarna group that analyzes yearly satellite imagery from 344 cities in 62 countries worldwide with AI technology, states that in 2024 the netting of urban green space additions and losses results in a total of 63 millions square meters of urban green space lost in comparison to 2023.[102] It is clear that the trend of increase of urban green space that is followed in the most advanced cities is not able to surpass or even neutralize the increasingly denser construction or abandonment of land in most urban surroundings. From Greek cities, only Athens is included in the research and is ranked 328th among 344 cities and has a negative change in the development of green space, even though it is not clear to which extent.

Following diagrams and maps which visualise some of the facts described above:

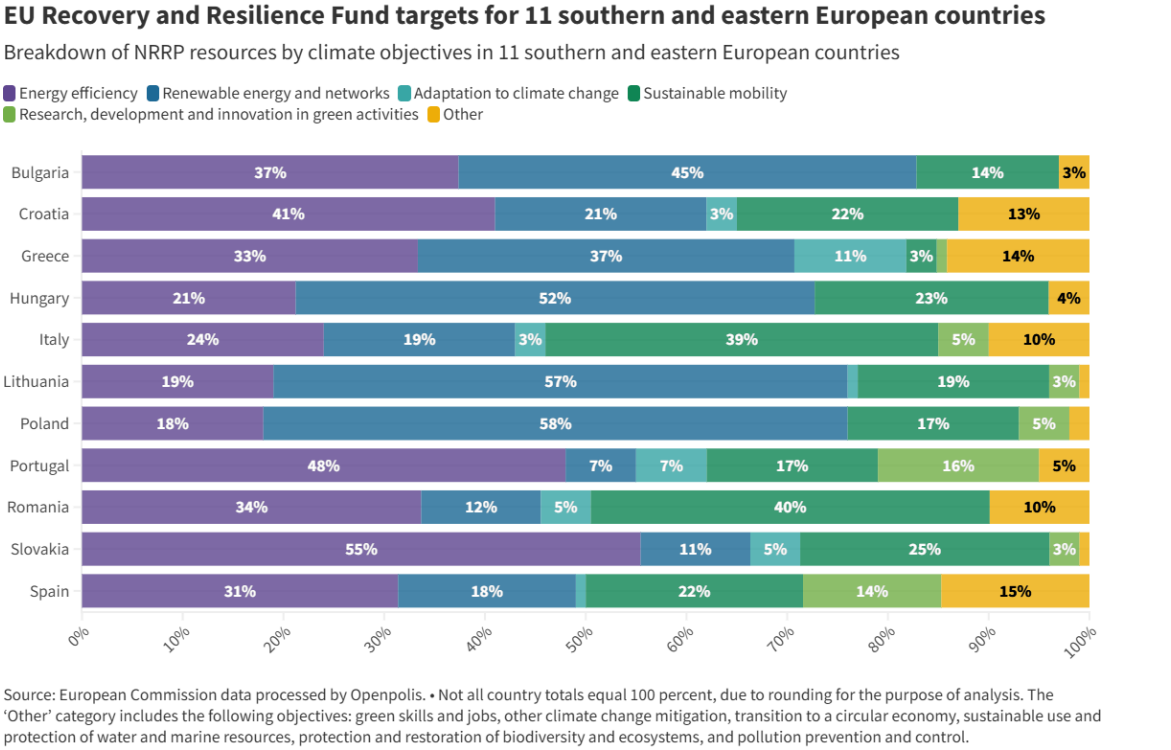


Source: Article of EEA "How green are European cities? Green space key to well-being – but access varies"
Data sources: Copernicus Land Monitoring Services – Urban Atlas, 2018

Bar chart that displays three different indexes on the total of the square meter area on 38 studied European capital cities for 2018: the percentage of all green infrastructure on the area (yellow line), the percentage of the tree cover on the area (blue line) and the percentage of the urban green space on the area (red line). By definition, the share of urban green space or tree cover cannot exceed the share of the total green infrastructure. Vertical axis has listed the cities by decreasing order of green infrastructure share and horizontal axis has the percentage of the total area of the cities. We cannot identify a trend of geographic location

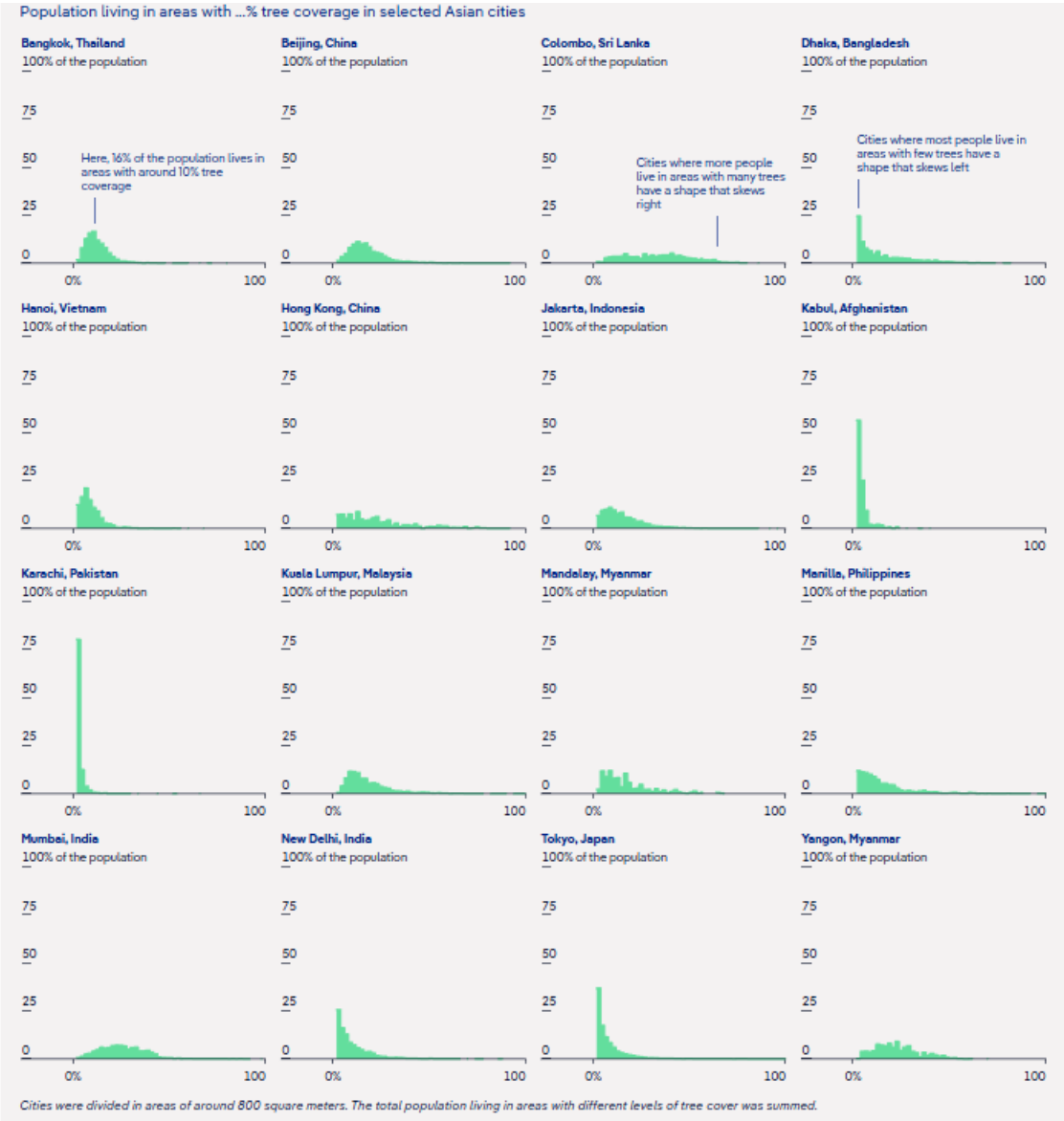
or national wealth corresponding to the proportional size of a city's green infrastructure. Nonetheless, Athens stands in the penultimate position with more green infrastructure only from Valetta, with green infrastructure occupying less than 20% on its area.

World Health Organization states that no household should reside in a distance greater than 300 meters from some sort of green space, which should be of a minimum size of 0.5 hectares. According to that statement, 62% of the European population live in areas with less green than recommended.[103]



Source: Article of European Data Journalism Network "Greece's shaky "green" investments" September 2024

Stacked bars chart that demonstrates the specific domains where funds from National Recovery and Resilience Plans (NRRP) were allocated in 11 selected Member States of the EU as a percentage of the total funds as of 2024. Each bar is consisted of different colored parts with assigned percentages that sum to 100%. Purple stands for energy efficiency, dark blue to renewable energy and networks, light blue to adaptation to climate change, dark green to sustainable mobility, light green to research, development and innovation in green activities and yellow to other. Out of the six categories, urban greening is most probably referring to the 'other'. We observe that Greece's allocation of funds towards this 'other' category is the second highest after Spain, at 14%, and is the third most important pillar of resources allocation for Greece after energy efficiency (33%) and renewable energy. Notably, the 'other' category does not exceed 15% of funds allocation for the selected states, and in six cases it is below 5%.



Source: DW article "How green are Asia's cities?", January 2024

Set of histograms that depict what proportion of the population in large Asian cities resides in areas under what levels of urban tree coverage. Vertical axes refer to the population percentages and horizontal axes refer to the area's tree coverage percentage. We observe that in most cases over 90% of the city's population is living in areas with less than 30% tree coverage. Exceptionally different is the image of Mumbai in India, Myanmarese cities and Columbo in Sri Lanka which have a more even distribution with a circa 50% share of their population living in areas with 30% and above tree coverage.

❖ **Section's summary**

Urban settlements are concerning the majority of the Earth's population. That being stated, urban environmental conditions and lifestyle are affecting human health in unprecedented

ways in human history. Outside from the sedentary lifestyle and unhealthy diets, urban settlements house some unique environmental phenomena such as urban heat island effect and urban canyon effect, adding strain on their residents.

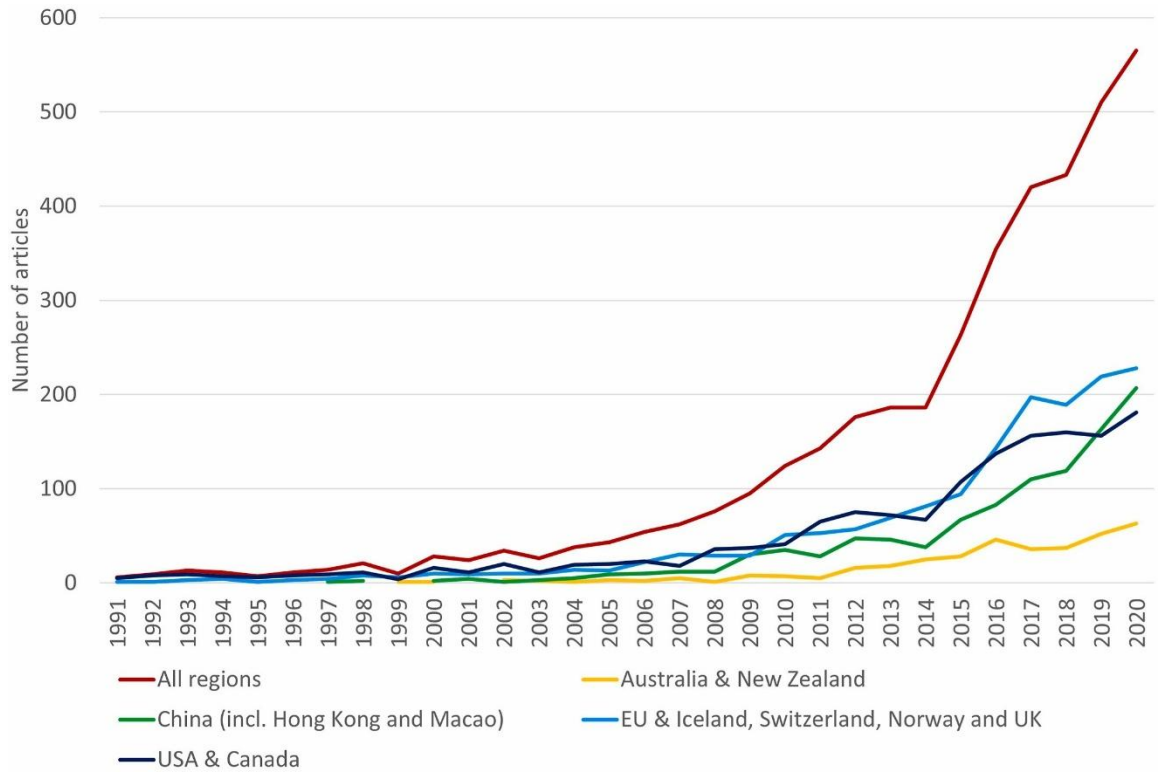
Urban planning is promoted as a way to minimize burdensome environmental conditions created by urban settlements. The enhancement and expansion of urban green spaces is believed to help towards that direction and for that reason is promoted in most advanced economically countries, even if it lags behind other investments that refer to energy sufficiency and resilience. In most countries the green space ratio proposed by World Health Organization is a still unmet goal, even though the range of the distance from this goal varies from region to region, with European and North American regions showing a generally better image than their Asian and African counterparts.

Same is the case for Greece, who is ranked notoriously low in all urban planning indexes for open and green spaces, such as green spaces coverage and proximity of residents to a green space. Researchers confirm the negative effects of its unruly planning and severe lack of vegetation in urban heat island effect. Nonetheless, it seems that Greece has allocated more funds from National Recovery and Resilience Plans, an EU funding program, towards greening projects.

Still the greatest picture for global cities is not rather optimistic as more urban green space is lost than created during the latest years and urgent action must be taken in order to have viable cities with natural elements for future generations' quality of life and better health, since open and green spaces affect aspects that range from solar access to air pollution and temperature.

4) Effects of urban green space on health

It is proven that scientific articles and studies referring to urban green spaces have increased by geometric progression in the latest decade.[104] It is safe to deduce that many of them refer to the beneficiary effects of urban green space on the general health of individuals that live within.



Number of articles focusing on urban green spaces. 27.3% of all articles involved in the analysis were produced in 2019 and 2020.
Source: review article "A systematic review of urban green space research over the last 30 years: A bibliometric analysis", February 2023

Line graph that displays the trend of published articles on the topic of urban green spaces throughout the years from 1991 to 2020. Vertical axis represents the absolute number of published articles, horizontal axis represents the years in scope and colored lines refer to the published articles ordered by geographic region: yellow line refers to the articles published in Australia and New Zealand, green line refers to China, navy blue line refers to USA and Canada, light blue line refers to EU, Iceland , Switzerland, Norway and UK and red is the cumulative trend of all the rest. We observe that the number of publishments started increasing mildly in the year 2000 to becoming more intensive after 2007 and skyrocket after 2014 without having reached a plateau. From the regions in scope, the one that differs on the intensity of the general trend is Australia and New Zealand who only seem to increase their publishments after 2014 in a seemingly less vigorous manner than the rest of the regions. Of course, this might be due to the smaller number of research hubs in these regions. Nevertheless, the shift of interest over urban green spaces is an undisputable trend in the ongoing scientific research.

Although the share of studies concerning the relation of urban green space and human health may not hold the strongest scientific evidence due to some serious methodological constraints, the trend of positive correlation between the two is undisputed in both direct and indirect aspects. These facts should mobilize policymakers towards specific measures that enhance the quantity and quality of urban green spaces.

Methodological constraints

Even though the vast majority of research suggests that green space is beneficiary for human health, we must take acknowledgement of the several methodological constraints this phrase beholds.

- **The variable isolation issue**

Surprisingly, green space is not linked only positively with human health. A recent study concerning the incidence and prevalence of psoriasis - an autoimmune disease that follows the rising trend of all chronic diseases in scope[105]- concludes that natural environments and green areas are positively related to prevalence of psoriasis.[106] Additionally, studies that relate green space and risk of dementia found a non-linear correlation where if green space outsizes a certain level, then risk of developing dementia starts increasing along again.[107] Not to mention the negative effects of allergenic pollen vegetation used in urban green parks.[108] Induced allergies aggravate chronic asthma, respiratory and cardiovascular disease.

The instances above are mentioned in order to underline the difficulty that lies in insulating the variable of greenness per se. Researchers try to study the effect of green environments on human health but may fail to exclude the bias of correlated factors that co-exist with greenness or are mutually excluded. That is, psoriasis may have higher prevalence in green areas due to richer presence of fertilizers and pesticides and not due to the natural environment per se. Or dementia may increase in deserted rural areas due to isolation and not due to the greenness per se. Respectively, chronic obstructive pulmonary disease recedes after urban greening interventions, but that is mostly due to air pollution mitigation and physical activity promotion which accompany green spaces.[109] And for neurological degeneration, greenness may ease the incidence and progression of dementia and other neurological diseases, not due to the greenness per se but due to the walkability and the socialization opportunities it offers.[110] Additionally, induced allergies are not an inevitable outcome of green spaces, but a result of the introduction of non-native allergenic species in urban grassland.[111] Eventually the green space factor on human health is rarely perceived merely at its pure essence. Instead, it is mostly a proxy statement for more implied factors.

- **Green Infrastructure versus Green Accessibility**

As presented already, a great number of green infrastructures in cities are not publicly accessible but are considered in urban green coverage and green per capita indices, as much of the data collection is perceived via satellite imagery or administrative land-classification data. We can assume that type of urban green is affecting only indirectly the general population's health by mitigating the urban heat island effect and balancing CO2 emissions.

Around the same topic lies the issue of green gentrification of cities, where urban greening interventions result in increasing prices of land, attraction of higher income households and eventually in displacement of the green-deprived working class in residencies that still lack green infrastructure,[112]or even adding to the urban sprawl of the unprivileged suburbs. Such

trends are identified in the EU[113] and specifically in Athens's area as well.[114] We can assume that the health effects of such interventions are not substantially positive to the general population, if not aggravating in terms of displacing whole neighborhoods to house already privileged households in the newly green gentrified areas. Consequently, it is important to keep in mind that even green infrastructure might have class barriers.

- **Green infrastructure measurements**
  As mentioned already, urban green areas can include from private gardens to green roofs, from plain open spaces and lawns to urban forests[115], albeit most of the studies relating green space to human health only refer to parks and other visible and accessible forms of greenery in the city. For example, a common unit for measuring green areas in American studies is the tree canopy percentage in a city.

  Furthermore, not all green spaces are of equal value and effect as the size and the land use classification are not good enough characteristics to guarantee any beneficiary effect. A series of other characteristics are also important to make a green space attractive for use, such as the maintenance work it is subject to, the sense of safety and other amenities (e.g. footpaths and seating)[116]. It is recorded even within EU and American countries that green spaces in unprivileged areas are more likely to be left neglected and damaged compared to those in higher income neighborhoods.[117]

  Additionally, it is observed that the cooling effects of green are not equal for cities closer to the Equator and cities closer to the North pole, but the factors causing this inequality are not thoroughly researched.[118] So, except for the unequal development between different regions of the world, other factors that are not directly considered, might affect the overall efficiency of green spaces, such as the specific climatic conditions of an area of interest, or the distribution of green spaces across the city.

Keeping these constraints in mind, we can deduce that the research around beneficiary effects of regenerated green spaces on human health indicates rather a trend of vaguely specific green interventions (parks, pathways, public gardens etc.), which implies several other coexisting factors, than an absolute codependency that proves the effect of natural environment interventions per se.

Indirect beneficiary effects

As it is subtly stated already, urban green spaces help reduce both behavioral and environmental risk factors for chronic diseases but also abate stresses that are mainly affecting urban environment. Green spaces are responsible for the mitigation of the Urban Heat Island Effect by a few crucial degrees, a slight decrease of air pollution[119], and -when combined with open spaces- the increase of sky view factor, solar accessibility, walkable space surrounding infrastructure and room for socialization. One can benefit from these 'side effects' even without having physical or visual contact with the greenery e.g. by people who may rarely even visit local parks but opt for walking around them to reach a place of interest or passively visit parks as a background to meet up with their acquaintances.

Another unlikely positive side effect is the noise absorption by green spaces in urban environments, a fact proven both by scientific measures as well as by residents' perception of noise and annoyance.[120]

Direct beneficiary effects

The positive effects of urban green spaces per se are dependent from the visual and physical contact of people with vegetation, whose density and quality affect directly human health. In this case green space is the destination that the citizen actively chooses rather than an indifferent background. The quality of the green space is evaluated by a series of characteristics such as vegetation masses, amenities, largeness, openness and maintenance. Urban residents might even commute long distances in the city to visit the parks they consider as of higher quality.[121] Studies indicate that the positive effects of one high quality green space in one neighborhood can have better results in terms of visitation and recreational physical activity than multiple green spaces of average perceived quality.[122] These actively green seekers visitors report positive effects on their mental and phycological health after prolonged stays in green spaces and overall better life satisfaction.

To strengthen the argument above, in a pulse conducted in India, park visitors reported as the primary reason for their visits the psychological and health benefits. Lagging was the social benefits and coming third the recreational benefits.[123]

Research has also indicated that when hospitals and rehabilitation centers are surrounded by green spaces and especially trees, patients' mental well-being and recovery time are boosted. A correlation of better pain tolerance and sleeping pattern of patients in health facilities surrounded by green is also identified.[124] In China, hospital affiliated green spaces are described as a soft environment of auxiliary function during rehabilitation process.[125]

Even one heavily limited observational research carried out in Greece points towards the same direction. In 2019, the visitors of Tritsi park in the western suburbs of Athens valued as the most important contribution of the park to be on the relaxation and recreation it offered for its visitors. The conductor of the specific research jumps to the conclusion that the lack of transportational connectivity of the park to the surrounding neighborhoods is not a serious problem as most of the visitors who arrived by car were satisfied. That methodological error occurs when the sample of data is heavily biased, and in our case contains only active visitors but not potential visitors who reside not far away but are discouraged from visiting due to high commuting cost.[126]

In a survey conducted in Thessaloniki in 2020, the participants who were visiting two urban parks (the Pavlou Mela and the HANTH) also answered that the main reason for their visit was recreation. In the specific research the different levels of visitors' satisfaction were associated with the overall service and amenities of the parks. Visitors of Pavlou Mela, which is located in a lower income district, were significantly less satisfied with the service they received and were more favorable to see the transformation of the park into a built infrastructure.[127]

Mental health in relation to green spaces is even recorded in the WHO with a publication in 2019 where the benefits were documented, and actions were suggested for the future of urban design.[128] The review suggests that urban green spaces help easing the depression

experienced by chronic disease patients. More reviews suggest that visual and physical exposure to natural setting helps reduce stress levels, as measured by cortisol in blood.[129]

Both directly and indirectly, green urban spaces appear to have beneficiary effects on human health and especially on chronic conditions. More studies indicating a positive relation of urban green spaces to general health and chronic disease prevention and alleviation have been conducted worldwide. The following are some indicative instances:

- Cohort studies in China compare the measurable health outcomes of people who visited parks and of people who only moved through urban built environment. Better outcomes were reported for people who visited parks. More specifically, they had lower pulse tension, psychological distress, BMI, lower glucose in blood, better immune system function, better sleep quality, better peripheral oxygen saturation and less vitamin D deficiency than those who only commute between dwellings.[130]
- A Finnish study in 2023 found a positive correlation between the number of visits to urban green spaces and reduced amounts of prescribed drugs for numerous chronic conditions such as anxiety, insomnia, depression, asthma and high blood pressure.[131]
- An American study even correlated the good cellular health to visits to urban green spaces.[132]
- Open cohort American research used Google Maps' images and combined these to the zip codes of the number of residents to identify the relation between the green spaces of each neighborhood and the chance of its residents to develop Parkinson Disease. The results showed that the more trees an area had, the less probable it was for its residents to develop Parkinson. However, the more common the presence of grass was, the more probable for the residents to develop Parkinson was.[133]
- A Canadian cohort study published in 2020 indicated a mild protective effect of greenness in citizens' surroundings from manifestation of neurological chronic diseases such as non-Alzheimer dementia and Parkinson. Alzheimer dementia and multiple sclerosis remained neutral as greenness levels changed.[134]
- In relation to cancers, some studies suggest that regular visits to urban green space slightly reduce risks of lung and breast cancer, other types of cancerous incidence remained neutral[135], while others suggest that regular visits are even linked to increased rates of skin cancer.[136]
- A Dutch survey was conducted among members of the National Panel of people with Chronic Illness or Disability about their self-rated health status in a three-year course. This survey did not find any significant relation between the urban green spaces of the zip code each patient resided in and the rate of his or her health deterioration. That ineffectiveness was attributed to the limited mobility of chronic disease patients.[137]
- A study on Australian Metropolitan parks found that over 60% of their users were either standing, sitting or lying.[138] Similarly, an American observational study found that 68% of the individuals who frequented in parks were sedentary.[139]

Lastly, the most indicative factor of urban green space effect on the individual's health is probably the mortality rate among chronic patients. That is because the mortality rate is an objective observational measure. Most researchers agree that proximity to greenness decreases all-cause mortality rates, even though the specific decrease varies from less than 10% to over 30% or even more for residents living in greener areas. The latter can be due to the specific characteristics of the green spaces which are many times left concealed under

the wider and more abstract definition of green urban space. For example, some British researchers associated the size of urban green space to its effect on human health and found that while large and small parks had decreased all-cause mortality rate, medium size parks were negatively related to the urban dwellers health status, for yet undefined reasons.[140] Other researchers underline that reduced mortality from cardiovascular disease was mostly associated with a denser and larger morphology of green space's vegetation. What is more, the relatively large, complex shaped, cohesive and connected green spaces were associated with lower rates of chronic disease prevalence.[141]

While considering the various results derived by research concerning urban green space in relation to health, one must keep in mind the credible value of each such research, which is relevant to the size of the sample under analysis, the suitability of chosen methodologies to derive significant results (e.g. observational or interventional), the publication bias and even the setting of the variables. One Chinese overview on 154 papers that dealt with green space and its association to health had discouraging outcomes. Using the Grading of Recommendation, Assessment, Development and Evaluations (GRADE) framework for interventional searches and an established framework for the observational searches, the researchers declared that only a small amount of research could be graded as high credibility, while most of the meta- analytical evidence was graded as of low credibility and needed to be validated from more future studies. Of high credibility evidence was rated research that associated greenness with cardiovascular outcomes, birth outcomes, mental health, and mortality.[142]

Eventually it seems that researchers in all geographic Continents advocate in favor of urban green spaces to promote human health, not as an isolated measure or panacea, but in a holistic approach to lifestyle and healthcare medical support for the chronic disease patients and the general population to lead long lives of high quality and lower healthcare expenses.

❖ **Section's summary**

In the latest decades we observe growing interest in the topic of urban green spaces and consequently the relation between urban green spaces and the overall positive effect on human health.

Under the acceptance of serious methodological constraints that hinder the revelation of straightforward correlations, such as the variable isolation constraint and the measurement unit for urban greenness used in the research in scope, a positive trend is detected. Urban greenery is beneficial both in direct and indirect ways. Indirect positive effects are the reduction of several health risk factors that are otherwise very common in cities, such as urban noise, air pollution, reduced vehicle traffic and milder heat island effect. Direct positive effects are related to intentional contact with the natural elements of the green spaces and result in lower stress levels, smaller chances of developing a chronic disease and alleviation of multiple symptoms of chronic disease patients such as better health indices (e.g. lower blood pressure, lower cholesterol levels, faster rehabilitation etc.) and overall stamina, as certain types of vegetation seem to even increase the life span of chronic disease patients.

Research examples from Greece emphasize on the need for modernized city parks of high quality, as urban dwellers prefer even commuting long distances in order to spend time in these parks and relax.

It should always be noted that the overall positive effects of greenery concern less than half of the population of chronic disease patients studied in the vast majority of the research. The most of them are left unaffected in their weary health status. Nevertheless, it remains a significant auxiliary health factor, at a surprisingly lower cost than prescribed medication that provides the same results. More research is needed at a higher credibility level to obtain better knowledge around the direct health benefits of urban green spaces by various factors such as park size, type of vegetation, accessibility, types of other amenities etc. and by type of chronic disease in scope (mental chronic disease, cancers, cardiovascular diseases etc.)

5) Conclusion

Modernity has changed the way people live in technological, and material advance that previous generations could not possibly dare to imagine. Of course, new states of the matter brought new challenges for humanity. That is, the new industrial means of production and urbanization offered a myriad of new services and products that applied to any need possible and allowed the general population longer life spans but also highlighted the man-induced risk factors for chronic illnesses such as hyper saturated junk food, air pollution and sedentary lifestyle.

Chronic conditions began increasing in Western countries from mid-20th century alongside the increase of the risk factors that induce them. By 2020's the absolute number of people suffering one chronic disease still increases but at a decreasing rate, while Asian and South American countries experience more intense increase in the chronic disease prevalence, as they now undergo all the risk factors that precede chronic disease, such as industrial induced air pollution and inactive prolonged working models. Despite the rise of prevalence, we have a decline in mortality attributed to chronic disease nowadays, proof of the advances of modern medicine in the battle with chronic diseases.

Yet more people than before must endure daily the challenges set by their chronic condition, which may not be fatal, but remains significantly limiting. Alongside the rise of chronic disease prevalence, rise the overbearing costs for patients and the state, indicating that the conventional intensive care and pharmaceutical prescription methods of confronting illness are not enough to suppress the rising burden. A more holistic approach is needed, not only to provide a better quality of life to the patients but also to minimize public and private expenditure.

In parallel, it was not until relatively recently that the concentration of funds on 'green' investments, highlighted the beneficiary effects of urban green spaces on chronic patients, among others. Despite them not being of as critical importance as other factors, such as air pollution reduction or lifestyle shifts as smoking cessation, urban green spaces are proven to help mitigate the risk of premature death and disability adjusted life years of chronic patients and promoting healthier lifestyle for the general population.

The research on the topic of green space effects on human health is still on a primary level, albeit having an overload of data and meta-analyses produced and recorded only in the past decade. Further research is needed with concentration on the characteristics of green spaces that have the most beneficiary effect on human health or specific conditions (e.g. cooling during heatwaves, relaxation, promoting physical exercise etc.). Cross border research could

be also further promoted by international organizations such as WHO since the subject in scope affects all urban regions worldwide.

The correlation between urban green spaces and human health remains unequivocally accepted, albeit not knowing the exact extent of that correlation. Accordingly, green spaces have a preventive role against chronic disease, despite having alleviating effect even when a chronic disease is manifested (e.g. lessen the psychological distress of chronic patients), especially if the green space is equipped with amenities that ease the access for people with mobility limitations.

Consequently, the servants of public interest should invest in the green regeneration of cities by various means. Primarily they could draw detailed urban plans for the best possible utilization of deserted or dilapidated public infrastructures and their conversion into urban green spaces and even proceed in compulsory purchase or expropriation of private land if it is an obstacle in the green space planning scheme. Secondly, they could enhance the features of the existing green spaces by providing more amenities, better vegetation following best practices, better connectedness with the public transport, better maintenance service and even an enhanced sense of safety with more lighting etc.

The mere existence of green spaces is not enough to promote vigorous physical activity or healthier lifestyle in general. Healthy habits need to be boosted by awareness campaigns that are officially formulated and should be promoted at schools, large institutions, enterprises etc. For such campaigns to bear a significant outcome, suitable green spaces should be established beforehand throughout the cities and towns, that are accessible to the public.

Last but not least lies the suggestion for the ongoing funding of research on the topic of urban green spaces and their beneficiary effects on general health and chronic conditions, in order to collect stronger evidence on specific associations and obtain the ability to make more effective interventions in the urban fabric.

An innovative policy is what is already implemented in many western countries under the name of ‘green prescriptions’ where people who complain about chronic mental problems or even high blood pressure, lung disease and diabetes are complementarily prescribed with green space visits by general practitioners.[143] If these patients were answering questionnaires regarding the type of vegetation, the time spent on green space, the activities they engaged in and the effects on their health, it would provide a whole new database of information around the topic, in a relatively low cost, as economy of scale would be achieved: the pool providing the answers would cover most of the population with medical insurance, and the central planning of the questionnaire would prevent methodological mistakes- at least to a significant level. The subjective bias of the answering individuals would be the only serious constraint.

All the above require considerable amounts of funding and multidisciplinary professionals to cooperate and be committed to research, development and erection of complex schemes from the domain of medicine, urban planning, commuting, ecology, statistics, information technology etc. As these lines are written it seems that, on a global level, urban green space is not following the rate of urbanization and even in the cases of big western cities where green spaces increased in numbers in recent years, the availability of green space per capita

is mostly lagging behind WHO's targets. The continuity of available funds towards such projects is doubtful especially as global economy shifts towards arming and defense.

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